Before-School Running/Walking Club:

Effects on Physical Activity and On-Task Behavior

by

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A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Approved April 2014 by the
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May 2014

ABSTRACT

Background: Childhood obesity is one of the most serious public health concerns in the United States and has been associated with low levels of physical activity. Schools are ideal physical activity promotion sites but school physical activity opportunities have decreased due the increased focus on academic performance. Before-school programs provide a good opportunity for children to engage in physical activity as well as improve their readiness to learn. **Purpose:** The purpose of this study was to examine the effect of a before-school running/walking club on children's physical activity and on-task behavior. **Methods:** Participants were third and fourth grade children from two schools in the Southwestern United States who participated in a before-school running/walking club that met two times each week. The study employed a two-phase experimental design with an initial baseline phase and an alternating treatments phase. Physical activity was monitored using pedometers and on-task behavior was assessed through systematic observation. Data analysis included visual analysis, descriptive statistics, as well as multilevel modeling. **Results:** Children accumulated substantial amounts of physical activity within the before-school program (School A: 1731 steps, 10:02 MVPA minutes; School B: 1502 steps, 8:30 MVPA minutes) and, on average, did not compensate by decreasing their physical activity during the rest of the school day. Further, on-task behavior was significantly higher on days the children attended the before-school program than on days they did not (School A=15.78%, *pseudo*-R^2=.34 [strong effect]; School B=14.26%, *pseudo*-R^2=.22 [moderate effect]). **Discussion:** Results provide evidence for the positive impact of before-school programs on children's physical

activity and on-task behavior. Such programs do not take time away from academics and may be an attractive option for schools.

DEDICATION

I dedicate my dissertation to my amazing nephew and niece, Michalis and Anna, who light up my world every time I hear their voices. I also dedicate this project to my 94-year-old grandma, whose unconditional love and kindness inspires me every single day. I could not forget my parents, Costas and Anna, and my sisters, Stella and Elena, who, in their own unique ways, kept reminding me what truly matters in life throughout this process. Finally, I dedicate this project to my dearest friends, Angelina, Magda, and Stephanie, who, despite the fact that they are thousands of miles away, have been next to me every step of the way.

ACKNOWLEDGMENTS

Pam and Hans, thank you for your continuous guidance. I am very grateful for all the support you have given me the last few years. I wouldn't have been able to do this without you and I am looking forward to continue working with you. Dr. Amazeen, Dr. Mahar, and Dr. Adams – your insights and guidance have greatly enhanced the quality of this project. Dr. Enders, I greatly appreciate your guidance with regards to my statistical analyses. Brian and Jeremy, thank you for all your help and flexibility. To the teachers and the students who participated in this project, thank you for welcoming us in your classes and schools - this project would not have been possible without you.

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Chapter 1: INTRODUCTION

Youth obesity constitutes one of the most serious public health concerns in the United States. According to the National Health and Nutrition Examination Survey (NHANES) data, between 1976-1980 and 2007-2008, the prevalence of BMI-for-age at or above the 95th percentile (i.e., obesity category) has tripled among school-aged children and adolescents (Ogden & Carroll, 2010). In 2009-2010, also according to the NHANES data, 16.9% of American children and adolescents aged two through 19 years were obese (Ogden, Carroll, Kit, & Flegal, 2012). Additionally, the prevalence of overweight and obese in American school-aged youth has been found to be the second highest (25.1% and 6.8%, respectively) in a study that compared data from 34 (primarily European) countries (Janssen et al., 2005).

Childhood and adolescent obesity is associated with various adverse health outcomes. Obese children and adolescents are more likely to have multiple cardiovascular disease risk factors (e.g., excess adiposity, adverse lipid concentration, and elevated blood pressure) (e.g., Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007; Thompson et al., 2007), and are at increased risk of metabolic-related complications (e.g., impaired glucose tolerance, insulin resistance, dyslipidemia, and type 2 diabetes) (Biro & Wien, 2010; Cali & Caprio, 2008; Daniels, 2006; Sinha et al., 2002; Weiss et al., 2004) and pulmonary disorders (e.g., asthma) (Papoutsakis et al., 2013). Beyond the physiological consequences, childhood obesity is also associated with psychological disorders, such as low self-esteem (Strauss, 2000), as well as social marginalization (Strauss & Pollack, 2003). Further, obese children are at a greater risk of becoming obese adults than normal-weight children (e.g., Biro & Wien, 2010; Freedman et al., 2007;

Herman, Craig, Gauvin, & Katzmarzyk, 2009; Thompson et al., 2007), which, again, is associated with various negative health conditions, including heart disease, diabetes, and some cancers (National Institutes of Health, 1998).

Low levels of physical activity have been identified as a significant contributor to the childhood obesity epidemic (Anderson & Butcher, 2006; Brock et al., 2009; Jago, Baranowski, Thompson, Baranowski, & Greaves, 2005; Stubbs & Lee, 2004; Trost, Kerr, Ward, & Pate, 2001; Weinsier, Hunter, Heini, Goran, & Sells, 1998). The U.S. Department of Health and Human Services (USDHHS, 2008) recommends that children and adolescents accumulate at least 60 minutes of physical activity each day, the majority of which should be moderate-to-vigorous intensity aerobic activity, including vigorous intensity aerobic activity on at least three days per week. Physical activity has multiple physical (i.e., related to cardiovascular health, musculoskeletal health, adiposity, and body weight management) and psychological/mental (i.e., enhanced self-concept, reduced anxiety and depression) health benefits for children and adolescents (Janssen & LeBlanc, 2010; Strong et al., 2005).

Despite the health benefits of physical activity, many children and adolescents do not meet the recommended physical activity guidelines (CDC, 2003, 2012; Troiano et al., 2008). Physical activity levels are associated with several factors, including the provision of opportunities to be physically active (Sallis, Prochaska, & Taylor, 2000), access to programs and facilities (Sallis et al., 2000), supervision (Sallis et al., 2001), participation in physical education and school sports (Gordon-Larsen, McMurray, & Popkin, 2000; van der Horst, Paw, Twisk, & van Mechelen, 2007), and school physical activity-related policies (Ferreira et al., 2007).

Schools have been identified as primary sites for promoting physical activity (e.g., Institute of Medicine, 2013; Pate et al., 2006; World Health Organization, 2008) because of their potential to reach the vast majority of school-aged youth. Furthermore, facilities and equipment are often available as well as qualified personnel who can facilitate and supervise physical activity opportunities. Also, there is evidence that well-designed and well-implemented school physical activity programs can result in increases in the physical activity levels of youth (Jago & Baranowski, 2004; Matson-Koffman, Brownstein, Neiner, & Greaney, 2005; Salmon, Boot, Phongsavan, Murphy, & Timperio, 2007; Stone, McKenzie, Welk, & Booth, 1998; Timperio, Salmon, & Ball, 2004; van Sluijs, McMinn, & Griffin, 2007).

However, despite the potential of schools to effectively promote physical activity, most of the time children and adolescents spend in school is sedentary in nature (i.e., sitting) and, in addition, as a result of the current economic conditions and the heavy emphasis on improving standardized test scores, physical activity opportunities in school (i.e., physical education and recess) have decreased the last few years in favor of the core academic subjects (Center on Education Policy, 2007; Hardman, 2007). Further, only a very limited proportion of American elementary, middle, and high schools provided daily physical education or recess in 2006 (Lee, Burgeson, Fulton, & Spain, 2007). There is also no federal law about that mandates physical education in American schools and state mandates regarding physical education are broad and general (National Association for Sport and Physical Education [NASPE] and American Heart Association [AHA], 2012). It is clear that physical activity recommendations for children and adolescents cannot be met through physical education and/or recess alone.

There is evidence that multi-component, comprehensive, and coordinated interventions (e.g., including physical education, physical activity breaks, etc.; targeting the curriculum, policies, and the school environment; involving families and the community) are more likely to be successful in increasing youth's physical activity levels than single-component interventions that do not involve families and/or communities (Salmon et al., 2007; Timperio et al., 2004; van Sluijs et al., 2007). Additionally, conclusions from the 2006 School Health Policies and Programs study point out the necessity of a comprehensive approach at the state, district, school, and classroom levels, in order to enhance physical education and physical activity in schools (Lee et al., 2007). Further, according to the Child Nutrition and WIC Reauthorization Act of 2004 (PL 108-265), districts with federally funded school meal programs are required to develop and implement wellness policies (effective from the 2006-07 school year), which target, among other components, physical activity.

Therefore, in order to help children accumulate the recommended amounts of daily PA and improve their health, a number of comprehensive initiatives have evolved over the last few decades in the U.S. that target health and/or PA in the school setting (e.g., the Coordinated School Health Programs by the Centers for Disease Control and Prevention). In 2008, the National Association for Sport and Physical Education (NASPE) issued a position statement recommending that all P-12 schools implement a Comprehensive School Physical Activity Program (CSPAP). A CSPAP includes five components: (a) physical education, (b) physical activity during school, (c) physical activity before and after school, (d) staff involvement, and (e) family and community involvement.

Although there is evidence that additional time spent in physical activity during the school day does not hinder academic performance as well as that it can improve on-task behavior, cognition, and academic performance (e.g., CDC, 2010; Trost & van der Mars, 2010), school administrators and teachers may still be reluctant to make the policy changes required for the adoption and implementation of comprehensive school physical activity programs. Before-school physical activity programs provide a good opportunity for students to engage in physical activity without taking time away from academics. Such programs have the potential not only to help students meet the daily physical activity recommendations and improve their health but also to help improve their on-task behavior at the beginning of the school day (Mahar, Vuchenich, Golden, DuBose, & Raedeke, 2011), which is an outcome that can motivate teachers and administrators to make policy changes related to the adoption of physical activity programs. In other words, before-school physical activity programs that do not influence the school schedule or curriculum can help reconcile the two clashing agendas of educational and public health goals (O'Sullivan, 2004) "imposed" on schools and alleviate the pressure on administrators and teachers to choose between the two. Running/walking clubs provide a good option for a before-school program since running and walking are lifetime physical activities and generate important health benefits. Therefore, the purpose of this study was to examine the effect of a before-school running club on students' physical activity and on-task behavior.

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Chapter 2: LITERATURE REVIEW (for both manuscripts)

This paper is split into two different manuscripts that examine the effects of a before-school running club on students' physical activity and on-task behavior, respectively. As has been described in the introductory chapter, both manuscripts are grounded in the public health literature and the call for schools to serve as physical activity promotion sites. The second manuscript is also grounded in the literature demonstrating the positive association between physical activity and students' classroom behavior, cognition, and academic performance.

A Before-School Physical Activity Program & Student Physical Activity Levels

Childhood and adolescent obesity has significantly increased the last few decades (Ogden & Carroll, 2010) and is associated with various adverse health outcomes (e.g., increased risk for developing multiple cardiovascular disease risk factors, metabolic-related complications, pulmonary disorders, and psychological disorders; increased risk of becoming obese adults; Daniels, 2006). A significant contributing factor to the childhood obesity epidemic is physical inactivity or low levels of physical activity (Anderson & Butcher, 2006; Brock et al., 2009; Jago, Baranowski, Thompson, Baranowski, & Greaves, 2005; Stubbs & Lee, 2004; Trost, Kerr, Ward, & Pate, 2001; Weinsier, Hunter, Heini, Goran, & Sells, 1998).

The U.S. Department of Health and Human Services (USDHHS, 2008) recommends that children and adolescents accumulate at least 60 minutes of physical activity each day, the majority of which should be moderate-to-vigorous intensity aerobic activity, including vigorous intensity aerobic activity on at least three days per week. USDHHS (2008) also recommends engaging in muscle strengthening and bone strengthening activities on at least three days per week. Physical activity has multiple physical (i.e., related to cardiovascular health, musculoskeletal health, adiposity, and body weight management) and psychological/mental (i.e., enhanced self-concept, reduced anxiety and depression) health benefits for children and adolescents (Janssen & LeBlanc, 2010; Strong et al., 2005).

However, despite the health benefits of physical activity, the results of studies employing national representative samples show that many children and adolescents do not meet the recommended guidelines (CDC, 2003, 2012; Troiano et al., 2008). For example, Troiano et al. (2008), who analyzed the 2003-2004 NHANES physical activity data measured by accelerometry, found that only 42% of children (ages 6-11 years) and 6-8% of adolescents (ages 12-19 years) met the recommended 60 (or more) minutes of (at least) moderate physical activity per day. Also, according to the 2011 Youth Risk Behavior Surveillance System data (CDC, 2012), only 28.7% of high school students reported having been physically active at a moderate intensity at least 60 minutes per day on all seven days before the survey. Additionally, the 2002 Youth Media Campaign Longitudinal Survey (CDC, 2003), which collected data from both children and parents, revealed that 61.5% of children aged 9-13 years had not participated in any organized physical activity during their non-school hours in the preceding seven days as well as that 22.6% did not engage in any free-time physical activity during the week prior to the survey.

The role of schools. Schools have been identified as an ideal setting for physical activity promotion (e.g., Institute of Medicine, 2013; Pate et al., 2006; World Health Organization, 2008) because of their potential to reach the vast majority of school-aged youth. It is characteristic that youth physical activity levels are associated, among other factors, with the provision of opportunities to be physically active (Sallis, Prochaska, & Taylor, 2000), access to programs and facilities (Sallis et al., 2000), supervision (Sallis et al., 2001), participation in physical education and school sports (Gordon-Larsen, McMurray, & Popkin, 2000; van der Horst, Paw, Twisk, & van Mechelen, 2007), and school physical activity-related policies (Ferreira et al., 2007). In accordance, schools provide various opportunities for physical activity participation (i.e., physical education class, recess, extracurricular activities, lunchtime physical activity, and other), and often have the required resources (i.e., facilities and/or equipment) and personnel with adequate training who can define physical activity policies as well as organize and facilitate physical activity programs.

Well-designed and well-implemented school physical activity programs can result in increases in the physical activity levels of youth (Jago & Baranowski, 2004; Matson-Koffman, Brownstein, Neiner, & Greaney, 2005; Salmon, Boot, Phongsavan, Murphy, & Timperio, 2007; Stone, McKenzie, Welk, & Booth, 1998; Timperio, Salmon, & Ball, 2004; van Sluijs, McMinn, & Griffin, 2007). However, despite the potential of schools to effectively promote physical activity, most of the time children and adolescents spend in school is sedentary in nature (i.e., sitting) and, in addition, as a result of the current economic conditions and the heavy emphasis on improving standardized test scores, physical activity opportunities in school (i.e., physical education and recess) have decreased the last few years in favor of the core academic subjects (Center on Education Policy, 2007; Hardman, 2007).

Comprehensive and coordinated approaches to increasing physical activity.

The results of several review studies that investigated the effectiveness of physical activity interventions in youth indicate that multi-component (e.g., involving physical education, physical activity breaks, etc.; Salmon et al., 2007; van Sluijs et al., 2007), comprehensive (i.e., whole-of-school approaches, including curriculum, policy, and environmental strategies; Timperio et al., 2004) and coordinated interventions (i.e., involving families and/or communities; Salmon et al., 2007; van Sluijs et al., 2007) are more likely to be successful in increasing youth physical activity levels than single-component interventions that do not involve families and/or communities. Additionally, the 2006 School Health Policies and Programs study's conclusions stress the necessity of a comprehensive approach at the state, district, school, and classroom levels, in order to enhance physical education and physical activity in schools (Lee, Burgeson, Fulton, & Spain, 2007).

Therefore, to attack the obesity epidemic and help children accumulate the recommended amounts of daily PA and improve their health, a number of comprehensive initiatives have evolved over the last few decades in the U.S. that target health and/or PA in the school setting (e.g., the Coordinated School Health Programs by the Centers for Disease Control and Prevention). In 2008, the National Association for Sport and Physical Education (NASPE) issued a position statement recommending that all P-12 schools implement a Comprehensive School Physical Activity Program (CSPAP). A CSPAP includes five components: (a) physical education, (b) physical activity during school, (c) physical activity before and after school, (d) staff involvement, and (e) family and community involvement.

Before-school programs. Before-school (along with after-school) physical activity programs are one of the components of a CSPAP (NASPE, 2008) and refer to any type of program that focuses on the promotion of physical activity at the school setting or through the school. In its CSPAP Policy Continuum document, NASPE (2012) identifies the optimal policy related to before-school and after-school programs as one that requires the provision of 30-60 minutes of morning or after-school physical activity, of which 50% should be spent in moderate-to-vigorous physical activity (MVPA). However, few studies could be identified that focused on before-school programs (other than active commuting). Some information on student physical activity levels before school is, however, available. This information is presented in the next section, which is followed by a section on active commuting to school.

Before-school physical activity patterns. Although much attention has been given to youth's physical activity levels in the last few years, only six descriptive (i.e., non-intervention) studies could be identified that focused on before-school physical activity patterns. These studies examined various questions, employed different designs as well as different instruments (i.e., pedometers, ActiGraph GT1M accelerometers, and systematic observation) to assess physical activity, and they also assessed before-school physical activity for various durations of time. Three of these studies were conducted in the U.S. (McKenzie, Crespo, Baquero, & Elder, 2010; McKenzie, Marshall, Sallis, & Conway, 2000; Tudor-Locke, Lee, Morgan, Beighle, & Pangrazi, 2006); the remaining three were conducted in northwest England (Fairclough, Beighle, Erwin, & Ridgers 2012; Fairclough, Butcher, & Stratton, 2007, 2008).

A few results of these studies are worth mentioning. First, Tudor-Locke et al. (2006) found that sixth grade Arizonan boys and girls (*N*=81; boys=28, girls=53) accumulated an average of 1784 (*SD*=948) and 1504 (*SD*=856) before-school steps per day, which represented about 11% and 12% of their average 24-hour steps, respectively. It is noteworthy that students' steps before school (combined for boys and girls: 1601±893) were significantly more than their steps during physical education class (1417±487) and recess (1177±523). Second, the findings of Fairclough and colleagues (2007, 2008, 2012) indicated that children may accumulate between five and 15 minutes of MVPA before-school, which may seem as little physical activity but actually represents a significant proportion of the recommended 60 minutes of MVPA per day, particularly for low active children.

Third, the findings of McKenzie and colleagues (2000, 2010) that both boys and girls engaged in significant portions of before-school MVPA (i.e., between 40% and 60% of time spent in activity areas before school) show the potential of before-school time to significantly contribute to children's overall physical activity levels. At the same time, it is concerning that only an average of 4.1% of all students attending school visited activity areas before school in the McKenzie et al. (2000) study. Also concerning is the finding that activity areas were significantly less accessible as well as less often supervised, organized, and equipped before school compared to other periods of the day (recess, lunch, and after-school) in both studies (McKenzie et al., 2000, 2010).

Before-school time is a time when children can choose to be active or inactive. During such time periods, busing students to school on time (which was significantly and positively related to the percentage of daily school attendance in activity areas in McKenzie et al., 2000), providing more accessibility to activity areas, as well more supervision, equipment, and organized activities, may encourage more students to be physically active. It is noteworthy that organized activities before school rarely occurred (i.e., only 8% of observations) in the McKenzie et al. (2000) study. Careful choice and structure of before-school activities may also help to eliminate potential sex differences in before-school activity area visits and physical activity levels like the ones found by McKenzie et al. (2000). The next section of the literature review focuses on active commuting to school as the primary method that has been used to increase students' physical activity levels before school.

Active commuting to school. Studies that targeted physical activity before school worldwide predominantly focused on active commuting to school. Systematic reviews in this area indicate a positive association between active commuting to school and youth physical activity levels (Davison, Werder, & Lawson, 2008; Faulkner, Buliung, Flora, & Fusco, 2009; Lee, Orenstein, & Richardson, 2008; Sirard & Slater, 2008). The (cross-sectional or quasi-experimental) nature of the vast majority of active commuting studies, however, makes it difficult to determine whether active commuting leads to increased PA or whether active children are simply more likely to walk. At the same time, Chillón, Evenson, Vaughn, and Ward (2011), found in their review study that most of the interventions had a small effect size on active commuting (i.e., there was only a slight increase in active transportation to school following the intervention). Finally, review studies in this area found no overall association between active commuting and weight status or body mass index (BMI) (Davison et al., 2008; Faulkner et al., 2009; Lee et al., 2008; Sirard & Slater, 2008).

Although active commuting to school for children and adolescents can potentially generate positive outcomes related to youth's physical activity levels, such programs may not be feasible for a large proportion of students because of significant barriers associated with them. Such barriers include, among others, travel distance (Davison et al., 2008; McMillan, 2007; Merom, Tudor-Locke, Gauman, & Rissel, 2006; Silva, Vasques, Martins,Williams, & Lopes, 2011; Trapp et al., 2012) and safety of the route (e.g., no lights or crosswalks, traffic, presence of bike lanes and well maintained paths, crime, etc.; Nelson & Woods, 2010; Silva et al., 2011; Timperio et al., 2006; Trapp et al., 2012).

Further, data from the National Household Travel Survey indicate that distance to school has significantly increased over time as well as that the percentage of K-8 students who actively commute (i.e., walk or bike) to school decreased from 47.7% in 1969 to 12.7% in 2009 (McDonald, Brown, Marchetti, & Pedroso, 2011). Over the same period, the proportion of K-8 students travelling to school by personal vehicle increased from 12.2% to 45.3% (McDonald et al., 2011). It seems, therefore, that alternative before-school physical activity programs may be required that can reach the vast majority of students and, at the same time, are free of the barriers associated with active commuting to school.

Other before-school programs. Only three studies could be identified in the literature that targeted before-school programs other than active commuting to school, two of which were intervention studies (Mahar, Vuchenich, Golden, DuBose, & Raedeke, 2011; Stylianou, Kulinna, & Kloeppel, 2014) and one a descriptive study (Mozen, Cradic, & Lehwald, 2010). Mozen et al. (2010) published a paper for practitioners describing the process of establishing a 15 to 20-minute before-school program for middle and high school students. The specific program involved a variety of activities, including aerobic training (treadmills, stationary bikes, stair stepper, two Play Station

Game Bikes), two Dance Dance Revolution systems, a basketball game, “Gotcha” basketball game stations, Ultimate Table Tennis, jump rope activities, cup stacking, as well as open/free play. A survey (*N*=47, 17 girls) towards the end of the school year revealed that students in grades 6-9 participated the most in the program, with 59.6% (*n*=28) of them participating daily. Additionally, 59.6% (*n*=28) of survey respondents indicated that they had increased heart rate with or without increased breathing and/or sweating. More than half of survey respondents (60.4%; *n*=29) indicated that the program influenced to some degree when they arrived to school.

In the second study with a before-school program (Mahar et al., 2011), the First-Class Activity Program was used with a group of third grade students, which was implemented through the HOPSports Training System, an interactive multi-media physical activity training system that utilizes DVR technology to engage large numbers of students in physical activity. This before-school program included sport-specific skills, dance, circuit, and other activities, and provided students with an opportunity to develop and enhance different motor skills. The authors of this study found that the students (*N* = 27; mean age = 8.2 ± 0.5 years) who participated in this before-school program spent an average of 46.4% of the available time (i.e., 30 minutes) in MVPA (9.3 ± 2.9 min) and obtained about a third of the recommended time for school-based physical activity.

Last, Stylianou et al. (2014) studied a before-school running/walking club in one American Indian community in the Southwestern U.S. in which both students (K-6; *N*=251) and teachers (*N*=24) participated. The findings of the study indicated that students covered between .6 and one mile per day during the running/walking club as well as that teachers perceived themselves as positive role models for the students in the running/walking club.

All three of the programs described above point out the potential positive outcomes of before-school programs. However, for the before-school program used by Mahar et al. (2011) but also for some of the activities (i.e., Dance Dance Revolution, Play Station Game Bikes) used in the program described by Mozen et al. (2010), there is a purchase fee as well as some other technological requirements (e.g., projector and screen), which may inhibit many schools from accessing and using them. A practical alternative for a before-school physical activity program may be a running and/or walking club, like the one used in the study by Stylianou et al. (2014).

Running clubs. Running clubs constitute one example of a component of a CSPAP. Running represents a lifetime physical activity and generates important health (e.g., weight management, improved cardiovascular fitness, reduction of risk of obesity, heart disease, diabetes, etc.), psychological, and other benefits (e.g., Sachs & Buffone, 1997). According to Ratliffe and Bostick (2001), the purpose of running (and walking) clubs is "to help children improve their ability to sustain continuous running and walking, identify walking and running as beneficial cardiorespiratory exercise, and participate in daily walking and running outside of regularly scheduled physical education class" (p. 24).

However, other than the study by Stylianou et al. (2014) described above, only a few studies could be identified that focused on running clubs/programs (Foshay & Patterson, 2010; Ratliffe & Bostick, 2001; Tuckman & Hinkle, 1986; Xiang, McBride, & Bruene, 2004, 2006; Xiang, McBride, Bruene, & Liu, 2007). Overall, these studies focused on various student outcomes (e.g., physiological outcomes like cardiovascular fitness/endurance, pulse rate, body fat, motivation, etc.) related to running clubs, which were offered mainly through physical education and recess. The only running club study that could be found that focused on physical activity levels is the one by Stylianou et al. (2014) but the particular study was conducted with a specific population (American Indian students) and did not use an objective measure of physical activity levels (instead, teachers counted laps). Clearly, there is a need to further study the potential contributions of running clubs and other types of before-school programming to students' physical activity levels.

Physical activity compensation. An issue related to the value and necessity of different school-based physical activity programs is physical activity compensation; that is, whether youth engage in less physical activity during the school day or after school on days with increased school-based physical activity programming. A review of related studies provides valuable insights related to this issue that have significant implications for the value of school-based physical activity programs.

First, youth do not seem to compensate on days with restricted school-based physical activity opportunities (e.g., physical education, recess) by being more active during the school day or after school (Alderman, Benham-Deal, Beighle, Erwin, & Olson, 2012; Dale, Corbin, & Dale, 2000; Morgan, Beighle, & Pangrazi, 2007). Second, youth do not compensate for increased school-based physical activity opportunities (including before-school programs) by engaging in less school-day (Mahar et al., 2011), after school or daily (Alderman et al., 2012; Dale et al., 2000; Morgan et al., 2007) physical activity. On the contrary, some studies' results indicate that, overall, children engage in more after-school and daily physical activity on days with increased school-based physical activity opportunities (Alderman et al., 2012; Dale et al., 2000). Morgan et al. (2007), however, found that only the most active students engaged in increased after-school physical activity on days with increased school physical activity programming.

In a study that analyzed a national dataset of objectively measured physical activity, Long et al. (2013) found that each additional minute of school-day MVPA was associated with an additional 1.14 minutes of total daily MVPA, or 0.14 additional minutes outside the school day. Gidlow, Cochrane, Davey, and Smith (2008) were the only investigators whose results indicated some type of compensation. Specifically, these authors found that about half (47.4%) of youth with the lowest in-school physical activity compensated by engaging in reduced physical activity out of school during the week and about one-third (30%) compensated by engaging in reduced physical activity during the weekend.

Together, these findings provide support for the importance of school-based physical activity opportunities. These opportunities can significantly help youth meet and/or exceed physical activity recommendations.

A Before-School Physical Activity Program & Student On-task Behavior

Beyond the health benefits of physical activity and its potential to help fight obesity, there is now a body of literature suggesting that physical activity opportunities in school may also improve students' classroom behavior, cognition, and academic achievement. For example, Sibley and Etnier (2003), in a meta-analytic review, found a significant positive relationship between physical activity and cognition in children, with an effect size of 0.32. Additionally, in a qualitative review of the literature on the association between school physical activity and academic performance (CDC, 2010), results indicated that physical activity may improve, but does not adversely impact direct or indirect measures of academic performance (50.5% positive, 48% insignificant, and only 1.5% negative associations). Moreover, in a review of research on the effects of short bouts of physical activity on attention-to-task in elementary school students, Mahar (2011) found small to moderate improvements on attention-to-task following physical activity breaks, with effect sizes typically ranging from 0.13 to 0.60.

Further research in this area "is needed to justify the incorporation of physical activity in school settings, especially to teachers and administrators" (Mahar et al., 2006, p. 2086), who may be hesitant to increase physical activity time throughout the school day because of the pressures they receive to improve academic performance (Cothran, Kulinna, & Garn, 2010). Demonstrating the cognitive and academic benefits of physical activity may alleviate some of their concerns and lead to additional physical activity programming throughout the school day.

Physical activity and classroom behavior. One aspect that is often explored in association with school physical activity participation is classroom behavior. For the purposes of this manuscript and similar to the definition provided in CDC's (2010) report (on the association between school physical activity and academic performance) for academic behaviors, classroom behavior includes various behaviors that may have an impact on students' adjustment and academic performance. These behaviors may include social and work aspects of classroom behavior, time-on-task, time-off-task, misbehavior, fidgeting, and other related types of behavior. Concentration and other types of cognitive functioning (e.g., executive control) measured through psychological and cognitive tests, as well as academic performance, are not considered as measures of classroom behavior and are therefore not included in this chapter/literature review.

The literature review in this chapter provides an overview of studies that have examined various expressions of children's classroom behavior following different types of physical activity and is organized into four sections based on the type of physical activity employed in each study (i.e., physical education, recess, classroom physical activity, and before-school physical activity). Each section is further divided and organized in the following subsections: (a) classroom behavior measures used, (b) classroom behavior evaluation process employed, (c) inter-observer reliability and (c) overview of findings.

Classroom behavior following physical education-related interventions. Two studies could be identified that investigated the effects of physical education-related interventions on students' classroom behavior (Dwyer, Blizzard, & Dean, 1996; Tuckman & Hinkle, 1986). Both studies in this section were conducted with students in the upper elementary grades.

Classroom behavior measures and evaluation. Both studies utilized validated behavior scales to assess students' classroom behavior, which were completed by the classroom teachers both prior to and following the interventions. Specifically, Tuckman and Hinkle (1986) used the Devereaux Elementary School Behavior Rating Scale (Swift, 1982), which consists of over 40 items rated on a 4-point scale that cover multiple behavior factors related to academic achievement or adjustment (e.g., work organization, irrelevant thinking/talking, etc.), whereas Dwyer et al. (1996) used the KAB Child Behaviour Scale (McGee, 1977), which consists of a series of 18 items rated on a 5-point scale and covers both social and work aspects of classroom behavior.

Findings. The results of the two studies described in this section are mixed. On the one hand, Tuckman and Hinkle (1986) did not find significant differences between groups (i.e., participation in regular physical education vs. running sessions) on classroom behavior. On the other hand, Dwyer et al. (1996) found significant improvements in classroom behavior following both the skill (9.32 ± 0.88 points; out of 90 possible points [18 items x 5-point scale for each]) and fitness groups (6.87 ± 1.07 points; out of 90 points) relative to the control physical education group (1.66 ± 0.74 points; out of 90 points).

Classroom behavior following recess. Five studies were identified that investigated the effects of recess on students' classroom behavior (Barros, Silver, & Stein, 2009; Jarrett et al., 1998; Pellegrini & Davis, 1993; Pellegrini, Huberty, & Jones, 1995; Ridgway, Northup, Pellegrin, LaRue, & Hightshoe, 2003). These studies were conducted exclusively with elementary school children and one of these studies (Ridgway et al., 2003) also focused on students with attention-deficit hyperactivity disorder (ADHD).

Classroom behavior measures. The five studies in this section focused on various classroom behavior measures. Barros et al. (2009) evaluated group classroom behavior based on a misbehavior frequency scale. Jarrett et al. (1998) examined participants' work (e.g., on-task behavior, doing assigned work, attending to the teacher), fidgety behavior (e.g., excessive movement, tapping, arm or leg swinging), and listless behavior (e.g., head on desk, starting outside). Pellegrini and Davis (1993) evaluated students' fidgety behavior (e.g., moving while seating, tapping feet, pencil, etc.) and concentration, which was defined as degree of attention to seat work or directness of gaze to work. Pellegrini et al. (1995) examined inattention, which was also determined by students' gaze (i.e., not looking directly at the teacher during the book reading/listening sessions; not looking directly at the activity, a peer in that activity, or the teacher if she was in the center or talking to the child/class). Last, Ridgway et al. (2003) looked at several aspects of inappropriate behavior: (a) off-task behavior – looking away from instructional materials for more than three seconds, (b) inappropriate vocalizations – any vocal noise or verbalization that was not preceded by the child's raised hand and acknowledgment by an adult, (c) out of seat - the child's full body weight not being supported by a chair or the child's buttocks removed from the chair, for at least three seconds, (d) fidgeting - repetitive unnecessary movements of any part of the child's body, and (e) playing with objects - touching any object that was not associated with an assigned task).

Classroom behavior evaluation. Four of the studies in this subsection evaluated students' classroom behavior using direct observation (Jarrett et al., 1998; Pellegrini & Davis, 1993; Pellegrini et al., 1995; Ridgway et al., 2003) whereas one study used teacher ratings of classroom behavior (Barros et al., 2009). Both Jarrett et al. (1998) and Ridgway et al. (2003) used partial interval recording. Pellegrini et al. (1995) used scan sampling and instantaneous recording, whereas Pellegrini and Davis (1993) used focal child sampling and instantaneous recording Finally, Barros et al. (2009) used teacher ratings of classroom behavior based on a 5-point scale (1 = misbehaves very frequently and is almost always difficult to handle, 5 = behaves exceptionally well).

Inter-observer reliability. Inter-observer reliability results were reported as acceptable for all four studies that used systematic observation. Pellegrini and Davis

(1993) reported inter-observer reliability scores of .83 and .77 for fidgeting and concentration codes, respectively. Pellegrini et al. (1995) reported inter-observer reliability statistic (Cohen's kappa) values above .60 for inattention in all three experiments (.75, .72, and .86, respectively). Jarrett et al. (1998) indicated that the percentages of agreement between pairs of observers ranged from 91.2% to 93% on work, 88.3% to 91.2% on fidgetiness, and 96.7% to 98.5% on listlessness. The authors also reported inter-observer agreement of over 90% percent on all variables during the second reliability check with an observer who was blinded to the study conditions (recess vs. no recess). Finally, Ridgway et al. (2003) reported that the average inter-observer agreement of inappropriate behavior was over 90% for all groups of students.

Findings. The results of the study conducted by Pellegrini and Davis (1993) can be divided into two categories: (a) pre-recess classroom fidgeting and concentration, and (b) playground behavior and post-recess classroom fidgeting and concentration. As far as pre-recess classroom behavior is concerned, all children fidgeted significantly more in the long (3-hour) confinement condition ($M = 3.32$; on a 7-point scale) than in the short (2.5-hour) condition ($M = 2.83$; on a 7-point scale). In terms of the relationship between playground behavior and post-recess, results indicated: (a) a significant positive relationship between both social and non-social play and fidgeting in class ($r = .15$ and $r = .13$, respectively), (b) a significant positive relationship of social sedentary recess behavior with concentration ($r = .14$) and a significant negative correlation between social sedentary recess behavior and fidgeting ($r = -.17$), and (c) a significant negative correlation between non-social sedentary recess behavior and concentration ($r = -.16$). Although the above results indicate that children who were more active (both socially and non-socially) during recess were more restless in the classroom, the strength of the relationships was very weak (< .20).

The results of the study by Pellegrini et al. (1995) can also be divided into two categories: (a) pre-recess inattention-to-task and (b) pre-recess vs. post-recess inattention-to-task. For pre-recess, the authors found that students' pre-recess inattention-to-task was greater during the long confinement period (i.e., when recess was offered 30 minutes later). However, this finding was significant only for kindergarten (mean differences (MD) = 1-33% based on gender and gender-preferred activity) and fourth grade (MD = 7-24%) students (not for second grade students) in experiment one and for fourth grade boys (MD = 3-39%) (not for fourth grade girls and second grade students) in experiment two. For pre-recess vs. post-recess, the authors found that inattention-to-task rates were higher before recess than after recess, both for outdoor and indoor recess. Again, however, this finding was significant only for second grade (MD = 8.39%) and fourth grade (MD = 1.70%) students (not for kindergarten students) in experiment one, for second grade students (MD = 1.78%) (not for fourth grade students) in experiment two, and for one (MD = 1.25%) of two fourth grade classes in experiment three (the only experiment where recess took place indoors).

Jarrett et al. (1998) examined both group effects and individual differences in their study. Regarding group effects, the results of the study indicated that on-task behavior significantly increased (90% vs. 85%) and fidgety behavior significantly decreased (7% vs. 16%) on days with recess compared to days with no recess. Mahar et al. (2011) estimated medium (Cohen's d = 0.51) and large (Cohen's d = 0.94) effect sizes for the on-task and fidgety behaviors, respectively. No differences were found for listless behavior. Concerning individual differences, the results of the study indicated that 60% of the participants, including all five students with attention deficit disorder, benefited the most (i.e., were at least one standard error of the mean above the mean difference score on a variable; on-task behavior +6.6%; fidgetiness -10.6%) from recess, either by improving on one or on both behaviors. On the other hand, however, six students seemed to function better without recess, although two of them reduced their fidgeting (an improvement) concurrently with decreasing their on-task behavior.

Ridgway et al. (2003), who evaluated the effects of recess on the classroom behavior of second grade children with and without ADHD, found similar results for both groups. Participants' levels of inappropriate behavior were consistently higher on days without recess than on days with recess. Also, participants' levels of inappropriate behavior progressively increased over time on days with no recess, which did not occur on days with recess. However, the effects of recess were greater for most of the participants with ADHD (35%, 41%, and 15% improvement) than for the groups of participants without ADHD (16%, 22%, and 16% improvement).

Finally, the results of Barros et al. (2009) are presented based on the two classifications of recess employed in the study. Based on the initial classification ('some' vs. 'no/minimal' recess), Barros et al. (2009) found that teachers' ratings of classroom behavior were significantly better for children with some recess (3.60 ± 0.85) than for those with no or minimal recess (3.44 ± 0.90). Mahar et al. (2011) estimated a small effect size (Cohen's $d = 0.18$) for this difference. Based on second classification with five subcategories for 'some recess', Barros et al. (2009) found that teacher ratings of classroom behavior were significantly better for all the groups with some recess than the ‘no or minimal recess’ group (mean differences ≤ 0.18). Mahar et al. (2011) estimated small effect sizes for these differences (Cohen's $d \leq 0.20$). At the same time, however, no significant differences were observed among the groups with different levels of exposure to recess.

The results of the studies in this section are difficult to compare due to the different research questions, designs, classroom behavior measures, and evaluation methods employed. Collectively, however, these studies provide evidence that recess physical activity breaks improve students’ classroom behavior and attention-to-task.

Classroom behavior following classroom physical activity. Four studies were identified that investigated the effects of classroom physical activity on students’ classroom behavior (Goh, Hannon, Fu, & Prewitt, 2012; Grieco, Jowers, & Bartholomew, 2009; Katz et al., 2010; Mahar et al., 2006). Of these studies, one is an unpublished study (abstract) that was presented at the 2014 AAHPERD national convention (Goh et al., 2012). All of the studies in this section were conducted with elementary school children.

Classroom behavior measures. From the four studies in this section, three focused on on-task and off-task classroom behavior (Goh et al., 2012; Grieco et al., 2009; Mahar et al., 2006). The study by Katz and colleagues (2010) was the only study in this section that did not focus on on-task and off-task measures to evaluate classroom behavior. In this study, classroom behavior was assessed by the work and social skills component of the district’s progress report, which comprised 14 classroom behavior-specific items.

Classroom behavior evaluation. The three studies in this section that focused on on-task and off-task behavior evaluated students’ classroom behavior using direct observation (Goh et al., 2012; Grieco et al., 2009; Mahar et al., 2006). Goh et al. (2012)

and Grieco et al. (2009) both employed momentary time sampling, recording the participants' behavior only at the moment at the end of the specified interval. Mahar et al. (2006) used whole interval recording (i.e., the behavior being observed must persist throughout the entire interval to be scored for that interval) for on-task behavior and partial interval recording (i.e., the behavior being observed is scored for that interval if it occurs at all during the interval) for off-task behavior. Finally, in the Katz et al. (2010) study, the work and social skills component of the district's report was evaluated and reported by classroom teachers. Specifically, each of the 14 classroom behavior-specific items were rated on a 3-point scale, with 3 being the most desirable score (satisfactory) and 1 the least desirable score (needs improvement).

Inter-observer reliability. Among the three studies in this section that used direct observation to assess student classroom behavior, only Mahar et al. (2006) and Grieco et al. (2009) provided detailed information regarding inter-observer reliability. In the Mahar et al. (2006) study, the mean percentage of inter-observer reliability during the study was 94% (range: 84% - 100%). In the Grieco et al. (2009) study, classes were divided into two sections in order to maximize the number of observations for each student and, thus, two observers were used to observe a whole class at a time, which prevented researchers from collecting inter-observer reliability data. However, inter-observer reliability was established in separate classrooms at the beginning, middle, and end of the study (90%, 92%, and 94 %, respectively).

Findings. The findings of the studies in this subsection are mixed. Two of the four studies found improvements in on-task behavior following short bouts of physical activity in the classroom. Specifically, Mahar et al. (2006) found a significant improvement of over 8% in students' on-task behavior from pre-Energizers to post-Energizers (70.9 ± 15.3 to 79.2 ± 11.4), which was of moderate effect (Cohen's d = 0.60). In addition, the authors found a stronger effect (Cohen's d = 2.20) for the least on-task students, who showed an improvement of 20% in on-task behavior from pre-Energizers to post-Energizers. Similarly, Goh et al. (2012) found a statistically significant improvement of 5% in students' on-task behavior between pre-active and post-active lessons.

Contrary to the results of the above two studies, Grieco et al. (2009), who examined the effects of a physically active classroom lesson and body mass index (BMI) category on elementary-aged children's time-on-task, found small, non-significant improvements in time-on-task following the active lesson for students of all BMI categories. However, Grieco et al. found significant decreases in time-on-task for students in all BMI categories following the inactive control lesson. Specifically, an inverse relationship was found between BMI and time-on-task after the inactive lesson, with overweight (26.5% decrease; Cohen's d = -1.28) and at risk for overweight (13.6% decrease; Cohen's d = -0.68) participants demonstrating greater decreases than normal weight participants (7.4% decrease; Cohen's d = -0.39). Finally, Katz et al. (2010) found no significant differences between the intervention and control groups in behavior changes from baseline as measured by the district's work/social skills progress report.

Classroom behavior following before-school programs. Only one study (abstract) was identified that investigated the effects of a before-school physical activity program on students' classroom behavior (Mahar et al., 2011). This study examined elementary students' (N = 27; mean age = 8.2 ± 0.5 years) on-task behavior in respect to the First-Class Activity Program, a 30-minute before-school program that included sport-specific skills, dance, circuit, and other activities, and was implemented using the HOPSports Training System. The design employed for this study was ABA (baseline, intervention, post-intervention/baseline) and on-task behavior was assessed via direct observation five days at baseline, five times during the eight-week intervention, and five times post-intervention.

Classroom behavior measures and evaluation. This study focused on on-task and off-task (motor, noise/verbal, and passive/other off-task) behavior and employed the same definitions as those used by Mahar et al. (2006). Classroom behavior evaluation was conducted through systematic observation and also followed similar procedures as those used by Mahar et al. (2006). Specifically, whole interval recording was used for on-task behavior and partial interval recording for off-task behavior. In this study, six to nine students were observed during each 30-minute observation period. Observation and recording intervals were both five seconds long. After one minute of observation (6 observation intervals) of the same student, the observers rotated to the next student to be observed. The rotation from student to student was repeated five times until each student had been observed for a total of three minutes or 18 observation intervals.

Findings. The findings of this study indicated that children were significantly more attentive during subsequent learning time on days they participated in the before-school physical activity program compared to days they did not. Specifically, the results indicated that on-task behavior significantly increased from baseline (61%) to intervention (79%), with a large effect size (Cohen's d = 1.17), as well as that it significantly decreased from intervention (79%) to post-intervention (64%), also with a large effect size (Cohen's d = 0.95).

Purpose

Before-school physical activity programs provide a good opportunity for students to engage in physical activity without taking time away from academics. Such programs have the potential to help students: (a) increase their physical activity levels, meet the daily physical activity recommendations, and improve their health, especially taking into account that children do not tend to compensate for the physical activity they receive through school-based programs by being less active during the rest of the school day or entire day, and (b) improve their on-task behavior throughout the school day, which is an outcome that can motivate teachers and administrators to make policy changes related to the adoption of physical activity programs. Running/walking clubs constitute one example of a component of a comprehensive school physical activity program and they provide a good option for a before-school program since running and walking are lifetime physical activities and generate important health benefits.

Given the scarcity of information on before-school programs, and specifically on running/walking clubs, and their impact on student physical activity levels and on-task behavior, the purpose of this study is to examine the effect of a before-school running/walking club on elementary school children's physical activity levels and on-task behavior. Specifically, this study will examine the following research questions:

1. How much physical activity (i.e., steps and moderate-to-vigorous physical activity [MVPA]) do children receive during the running/walking club and the school day?

2. Are there any differences between boys and girls or between normal weight and overweight/obese children in terms of physical activity levels accumulated during the running/walking club and throughout the school day?
3. Do children compensate for the physical activity they receive in the running/walking club by being less active during the rest of the school day?
4. Does children’s on-task behavior improve on days they participate in the running/walking club?
5. Are there any differences between boys and girls or between normal weight and overweight/obese children in terms of on-task behavior following the running/walking club?

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Chapter 3: A BEFORE-SCHOOL PHYSICAL ACTIVITY PROGRAM & STUDENT PHYSICAL ACTIVITY LEVELS

Childhood obesity constitutes one of the most serious public health concerns in the United States and is associated with various adverse health outcomes (e.g., increased risk for developing cardiovascular disease risk factors, metabolic-related complications, pulmonary disorders, and psychological disorders; increased risk of becoming obese adults) (Daniels, 2006). Low levels of physical activity have been identified as a significant contributor to childhood obesity (Brock et al., 2009; Jago, Baranowski, Thompson, Baranowski, & Greaves, 2005; Trost, Kerr, Ward, & Pate, 2001).

The U.S. Department of Health and Human Services (USDHHS, 2008) recommends that youth accumulate at least 60 minutes of physical activity each day, the majority of which should be moderate-to-vigorous intensity aerobic activity, including vigorous intensity aerobic activity on at least 3 days per week. Similarly, the daily step recommendation for children is 12000 steps per day, regardless of gender, which is thought to be equivalent to the recommendation of 60 minutes of moderate-to-vigorous physical activity per day (Colley, Janssen, & Tremblay, 2012).

Physical Activity Levels of U.S. Youth

Despite the extensive health benefits of physical activity (e.g., Janssen & LeBlanc, 2010), many children and adolescents do not meet the recommended guidelines (USDHHS, 2008). Using the 2003-2004 NHANES physical activity data measured by accelerometry, Troiano et al. (2008) found that only 42% of children and 6-8% of adolescents met the recommended 60 (or more) minutes of (at least) moderate physical activity per day. Also, according to the 2011 Youth Risk Behavior Surveillance System data (CDC, 2012), only 28.7% of high school students reported having been physically active at a moderate intensity at least 60 minutes per day on all seven days before the survey. Additionally, the 2002 Youth Media Campaign Longitudinal Survey (CDC, 2003) revealed that 61.5% of children aged 9-13 years had not participated in any organized physical activity during their non-school hours in the preceding seven days as well as that 22.6% did not engage in any free-time physical activity during the week prior to the survey. All above studies used nationally representative samples.

Generally, study findings indicate that physical activity levels significantly decline with age as well as that there are significant sex differences, with boys being more active than girls (Chung, Skinner, Steiner, & Perrin, 2012; Nader, Bradley, Houts, McRitchie, & O'Brien, 2008; Troiano et al., 2008; Trost et al., 2002). There is also some evidence suggesting that weight status is inversely related to physical activity (Chung et al., 2012). Based on these findings as well as the finding that children who are active are more likely to remain active during adolescence and adulthood (Malina, 1996), it is critical to promote physical activity participation as a lifestyle behavior from early years.

The Role of Schools

Schools have been identified as primary sites for promoting physical activity (e.g., Institute of Medicine, 2013; Pate et al., 2006; World Health Organization, 2008) because of their potential to reach the vast majority of school-aged youth. Additionally, schools provide various opportunities for physical activity participation (e.g., physical education, recess, extracurricular activities, etc.), and often have the required resources (i.e., facilities and/or equipment) and personnel with adequate training who can define physical activity policies as well as organize and facilitate physical activity programs.

Further, there is evidence that well-designed and well-implemented school physical activity programs can result in increases in the physical activity levels of youth (Salmon, Boot, Phongsavan, Murphy, & Timperio, 2007; Stone, McKenzie, Welk, & Booth, 1998; Timperio, Salmon, & Ball, 2004; van Sluijs, McMinn, & Griffin, 2007).

However, despite the potential of schools to effectively promote physical activity, most of the time children and adolescents spend in school is sedentary in nature (i.e., sitting) and, in addition, as a result of the current economic conditions and the heavy emphasis on improving standardized test scores, physical activity opportunities in school (i.e., physical education and recess) have decreased the last few years in favor of the core academic subjects (Center on Education Policy, 2007; Hardman, 2007). For example, a nationally representative survey of 349 school districts revealed that between the enactment of No Child Left Behind (2001-2002) and 2006-2007, 9% of elementary school districts have decreased physical education for an average of 40 minutes per week whereas 20% of districts have decreased recess time for an average of 50 minutes per week (Center on Education Policy, 2007). Also, the results of the School Health Policies and Programs Study (Lee, Burgeson, Fulton, & Spain, 2007) indicated that only 3.8% of all elementary schools provided daily physical education in 2006, whereas only 26% provided regular recess for all grades. Further, there is no federal law that requires physical education in American schools and, at the same time, state mandates regarding physical education are broad and general (NASPE & AHA, 2012). It is thus clear that PA recommendations for children and adolescents cannot be met through physical education and/or recess alone.

Comprehensive and Coordinated Approaches to Increasing Physical Activity

The results of several review studies that investigated the effectiveness of physical activity interventions in youth indicate that comprehensive (i.e., whole-of-school approaches, including curriculum, policy, and environmental strategies) (Timperio et al., 2004), multi-component (e.g., physical education, physical activity breaks, etc.), and coordinated (e.g., involving family and community) (Salmon et al., 2007; van Sluijs et al., 2007) interventions are more likely to be successful in increasing physical activity. Therefore, to help youth accumulate the recommended amounts of daily physical, a number of comprehensive initiatives have evolved in the U.S. that target the school setting. One of these initiatives is the Comprehensive School Physical Activity Program (CSPAP) concept that emerged in 2008 (NASPE, 2008) and includes five components: (a) physical education, (b) physical activity during school, (c) physical activity before and after school, (d) staff involvement, and (e) family and community involvement.

Before-school Programs

Before-school and after-school physical activity programs constitute one of the components of a CSPAP (NASPE, 2008). However, research related to this component has predominantly focused on after-school programs (e.g., Beets, Beighle, Erwin, & Huberty, 2009; Pate & O'Neill, 2009), possibly because they are more prevalent.

Before-school physical activity programs, which are the focus of this study, refer to any type of program that focuses on the promotion of physical activity at the school setting or through the school. In its CSPAP Policy Continuum document, NASPE (2012) identifies the optimal policy related to before-school and after-school programs as one that requires the provision 30-60 minutes of morning or after-school physical activity, of which 50% should be spent in moderate-to-vigorous physical activity (MVPA). The following sections focus on available information on physical activity levels before school, active commuting programs, and other before-school programs.

Before-school physical activity patterns. Although much attention has been given to youth's physical activity levels in the last few years, only six descriptive (i.e., non-intervention) studies could be identified that focused on before-school physical activity patterns. These studies, which were all conducted with elementary aged children, examined various questions, employed different instruments to assess physical activity (i.e., pedometers, accelerometers, systematic observation) and assessed before-school physical activity for various durations of time (from 30-minutes to about two hours).

The results of these studies show the potential of before-school time to significantly contribute to children's overall physical activity levels. Tudor-Locke, Lee, Morgan, Beighle, and Pangrazi (2006) found that students accumulated 1601±893 steps before school, which was significantly higher than physical education and recess steps. Fairclough, Beighle, Erwin, and Ridgers (2012) as well as Fairclough, Butcher, and Stratton (2007, 2008) found that, on average, children accumulated up to about 10 minutes of activity before school. Additionally, McKenzie, Marshall, Sallis, and Conway (2000) and McKenzie, Crespo, Baquero, and Elder (2010) found that both boys and girls who were present in activity areas before school engaged in significant portions of MVPA (i.e., between 40% and 60% of time spent in activity areas before school).

Study results regarding sex differences were mixed. Most studies found no differences between boys and girls for the before-school segment of the day (Fairclough et al., 2007, 2012; McKenzie et al., 2010; Tudor-Locke et al., 2006). However, McKenzie et al. (2000) found that significantly more boys than girls (6.7% vs. 1.6%) visited activity areas before school as well as that boys in activity areas engaged in more MVPA than did girls (59.6% vs. 40%).

It is noteworthy that organized activities rarely occurred (i.e., 8% of observations) before school as well as that only an average of 4.1% of all students attending school visited activity areas before school in the McKenzie et al. (2000) study. Before-school time is a time when children can choose to be active or inactive. During such periods, busing students to school on time, providing more accessibility to activity areas, as well more supervision, equipment, and organized activities, may encourage more students to be physically active. Careful choice and structure of before-school activities may also help to eliminate potential sex differences in before-school physical activity levels.

Active commuting to school. Studies that targeted physical activity before school worldwide primarily focused on active commuting to school. Although review studies in this area indicate a positive association with youth's physical activity (e.g., Faulkner, Buliung, Flora, & Fusco, 2009), one review study reported small effect sizes for most active commuting interventions (Chillón, Evenson, Vaughn, & Ward, 2011) and many studies identified significant barriers that prevent active commuting to school, including travel distance and safety of the route (e.g., Silva, Vasques, Martins,Williams, & Lopes, 2011; Trapp et al., 2012). Further, in the United States, distance to school has significantly increased over time and the percentage of K-8 students who actively commute to school decreased from 47.7% in 1969 to 12.7% in 2009 (McDonald, Brown, Marchetti, & Pedroso, 2011). It seems, therefore, that alternative before-school physical activity programs may be needed that can reach the majority of children and are free of the barriers associated with active commuting to school.

Other before-school programs. Only three before-school programs could be identified in the literature that did not target active commuting to school. The first program (Mozen, Cradic, & Lehwald, 2010) was a 15 to 20-minute program for middle and high school students that involved a variety of activities (e.g., aerobic training, basketball games, jump rope activities, open/free play, etc.) and was described in a paper for practitioners with an emphasis on how to establish similar programs. The other two programs (Mahar, Vuchenich, Golden, DuBose, & Raedeke, 2011; Stylianou, Kulinna, & Kloeppel, 2014) were interventions that focused on increasing physical activity.

In the Mahar et al. (2011) study, a 30-minute before-school program that included sport-specific skills, dance, circuit, and other activities, was used with a group of third grade students. The results of this study indicated that the participants spent an average of 46.4% of their time in the program in MVPA (9.3 ± 2.9 min) and obtained about one third of the recommended amount of school-based physical activity.

Stylianou et al. (2014) studied a before-school running/walking club that took place for 10-20 minutes every day in one American Indian community. The findings of the study indicated that: (a) students covered between .6 and one mile per day during the running/walking club, (b) there was a significant increase in the average daily distance students covered over time, and (c) there were some grade level and gender differences.

Both of the studies described above point out the potential positive outcomes of before-school programs. However, the before-school program used by Mahar et al. (2011) was implemented through an interactive multi-media physical activity training system that needs to be purchased and involved equipment for many of the lessons. These features may make a program like this inaccessible for many schools. A practical alternative for a before-school physical activity program may be a running/walking club.

Running/walking clubs. Running/walking clubs constitute one example of a before-school program. Running and walking represent lifetime physical activities and generate important health (e.g., weight management, improved cardiovascular fitness, reduction of risk of obesity, heart disease, diabetes, etc.), psychological, and other benefits (e.g., Sachs & Buffone, 1997). According to Ratliffe and Bostick (2001), the purpose of running/walking clubs is “to help children improve their ability to sustain continuous running and walking, identify walking and running as beneficial cardiorespiratory exercise, and participate in daily walking and running outside of regularly scheduled physical education class” (p. 24).

However, other than the study by Stylianou et al. (2014) described above, only a few studies could be identified that focused on running clubs/programs (Foshay & Patterson, 2010; Ratliffe & Bostick, 2001; Tuckman & Hinkle, 1986; Xiang, McBride, & Bruene, 2004, 2006; Xiang, McBride, Bruene, & Liu, 2007). Overall, these studies focused on various student outcomes (e.g., physiological outcomes like cardiovascular fitness/endurance, body fat, motivation, etc.) related to running clubs, which were offered mainly through physical education and recess. The only running/walking club study that could be found that focused on physical activity levels is the one by Stylianou et al. (2014), but the particular study was conducted with a specific population (American Indian students) and did not use an objective measure of physical activity levels (instead, teachers counted laps). Clearly, there is a need to further study the potential contributions of running/walking clubs to students’ physical activity levels.

Physical Activity Compensation

An issue related to the value and necessity of different school-based physical activity programs is physical activity compensation; that is, whether youth engage in less physical activity during the school day or after school on days with increased school-based physical activity programming. A review of related studies provides valuable insights related to this issue that have significant implications for the value of school-based physical activity programs.

First, youth do not seem to compensate on days with restricted school-based physical activity opportunities (e.g., physical education, recess) by being more active during the school day or after school (Alderman, Benham-Deal, Beighle, Erwin, & Olson, 2012; Dale, Corbin, & Dale, 2000; Morgan, Beighle, & Pangrazi, 2007). Second, youth do not compensate for increased school-based physical activity opportunities (including before-school programs) by engaging in less school-day (Mahar et al., 2011), after school or daily (Alderman et al., 2012; Dale et al., 2000; Morgan et al., 2007) physical activity. On the contrary, some studies' results indicate that, overall, children engage in more after-school and daily physical activity on days with increased school-based physical activity opportunities (Alderman et al., 2012; Dale et al., 2000). Morgan et al. (2007), however, found that only the most active students engaged in increased after-school physical activity on days with increased school physical activity programming.

In a study that analyzed a national dataset of objectively measured physical activity, Long et al. (2013) found that each additional minute of school-day MVPA was associated with an additional 1.14 minutes of total daily MVPA, or 0.14 additional minutes outside the school day. Gidlow, Cochrane, Davey, and Smith (2008) were the only investigators whose results indicated some type of compensation. Specifically, these authors found that about half (47.4%) of youth with the lowest in-school physical activity compensated by engaging in reduced physical activity out of school during the week and about one-third (30%) compensated by engaging in reduced physical activity during the weekend.

Together, these findings provide support for the importance of school-based physical activity opportunities. These opportunities can significantly help youth meet and/or exceed physical activity recommendations.

Conceptual Framework

This study focuses on a before-school program, one of the CSPAP components, and its effect on children's physical activity levels. It is grounded in the conceptual framework guiding CSPAP programs, which is based on a social ecological perspective acknowledging the interconnectedness between an individual and his/her environment, and assumes four interactive levels of influence (i.e., micro-, meso-, exo-, and macro-system) (Carson, Castelli, Beighle, & Erwin, in press). The basic premise of this model is that elements from each level of influence must function in synergy for effective and sustainable CSPAP implementation.

At the microsystem level, which includes all five CSPAP components, lies the selection of the before-school program as an addition to existing physical activity programming. The mesosystem level, which refers to different types of facilitators, includes the physical education teacher as the person who has the knowledge, skills, and dispositions to facilitate/run the before school program and create a safe (physically, socially, emotionally) environment for physical activity participation. This level also involves other resources, such as time and space allocation, as well as access to facilities.

The exosystem level, which mainly refers to leaders, involves the school physical activity champion (physical education teacher or other individual) who initiates the before-school program, approval and support from administration, as well as support from other school personnel and parent volunteers. Finally, the macrosystem or culture level (i.e., policy interventions and normative behavior and beliefs), involves the adoption of the before-school program, which is first and foremost a policy intervention, and conveys the message to children that their significant others (i.e., teachers, parents, etc.) value and encourage physical activity participation in the form of a before-school program.

Purpose

The information presented above indicates the potential of before-school physical activity programs to significantly contribute to students' physical activity levels, especially taking into account that children do not tend to compensate for the physical activity they receive through school-based programs by being less active during the rest of the school day or entire day. Running/walking clubs may be an ideal option for a before-school program since running and walking represent lifetime physical activities that generate important health benefits. Given the scarcity of studies focusing on before-school physical activity programs as well as running/walking clubs, the purpose of this study is to examine the effect of a before-school running club on elementary school children's physical activity levels in the running club and during the school day. Specifically, this study examined the following research questions:

1. How much physical activity (i.e., steps and moderate-to-vigorous physical activity [MVPA]) do children receive during the running/walking club and the school day?

2. Are there any differences between boys and girls in terms of physical activity levels accumulated during the running/walking club and throughout the school day?
3. Are there any differences between normal-weight and overweight/obese children in terms of physical activity levels accumulated during the running/walking club and the school day?
4. Do children compensate for the physical activity they receive in the running/walking club by being less active during the rest of the school day?

Methods

Participants and Settings

The participants for this study were third and fourth grade students (*N=88*) from two schools in the Southwestern U.S. The two schools were a purposive sample of schools that were interested in participating in the study and represented two different settings (i.e., private vs. public). The goal was not to compare the two schools but rather to replicate the study across the two settings. A more detailed description of the participants as well as two schools follows below.

School A. The first school was a K-8 private, independent school. In fall 2013, when the study took place, the total enrollment of school A was 273 students, the majority of which identified their ethnic background as Caucasian.

From this school, 40 third and fourth grade students initially volunteered to participate in the study. However, one student dropped out during the first week of the study, resulting in a final sample of 39 participants (3^{rd} grade=16, 4^{th} grade=23; male=14, female=25), the majority of whom identified their ethnic background as Caucasian (*n*=35; 89.74%). About one quarter of the participants (23.68%) were overweight or obese (mean BMI=16.97 kg/m^2; *SD*=2.90 kg/m^2). Detailed demographic information for the participants can be found in Table 1 in Appendix B.

At this school, students received two 45-minute physical education lessons per week, as well as daily recess during lunchtime (45 minutes combined). Other physical activity opportunities available at this school were a jump rope club (once a week), as well as various afterschool sport clubs (e.g., soccer, fencing, etc.). Active commuting to school was limited to non-existent at this setting.

In terms of the physical education curriculum, the physical education teacher mainly employed two curricular models: (a) the Dynamic Physical Education model (a multi-activity model) with a four-part lesson format – introduction, fitness, skill, and game (Pangrazi & Beighle, 2013), and (b) Sport Education, where students are grouped in teams for an entire unit and take on roles such as coach, referee, etc. (Siedentop, Hastie, & van der Mars, 2011). During the study, the content covered in physical education involved various topics, including pedometer lessons, volleyball, soccer, cup stacking, dancing, circuit stations, and climbing ropes.

School B. The second school was a K-6 public school. The total enrollment of school B during spring of 2014, when the study took place, was 451 students (57.43% Caucasian, 33.92% Hispanic, 8.65% other). Also, according to data from February 2014, 59.28% of the students in school B were eligible for free or reduced-price lunch.

From this school, 57 third and fourth grade students initially volunteered to participate in the study. However, one student dropped out during the first week of the study, resulting in a final sample of 56 participants (3rd grade=28, 4th grade=28; male=31, female=25), who identified their ethnic background as Caucasian (*n*=30; 53.57%), Hispanic (*n*=20; 35.71%), and Other (*n*=6; 10.71%). Twenty of the participants (43.49%) were overweight or obese (mean BMI=18.64 kg/m^2; *SD*=4.05 kg/m^2). Detailed demographic information for the participants can be found in Table 1 in Appendix B.

At this school, students received two 30-minute physical education lessons per week, as well as daily recess during lunch (40 minutes combined for lunch and recess). Other physical activity opportunities available at this school included an extra recess period once a week as well as a Fit Kids club that met once a week. Additionally, about 20% of the students who volunteered to participate in this study reported that they rode their bicycles or walked to school either occasionally or systematically.

In terms of the physical education curriculum, the district in which the particular school belongs to adopts the Dynamic Physical Education model (a multi-activity model) with a four-part lesson format – introduction, fitness, skill, and game physical education teacher (Pangrazi & Beighle, 2013). During the study, the units covered at this school were hockey, golf, football, jump rope, Frisbee, and track and field.

Research Design

This study employed a two-phase experimental design with an initial baseline phase and an alternating treatments phase. The alternating treatments design involves the rapid alternation of two or more treatments or conditions (e.g., no treatment vs. treatment) while their impact on the target behavior is measured (Barlow & Hersen, 1984; Cooper, Heron, & Heward, 2007). Rapid, however, "does not necessarily mean rapid within a fixed period of time" (Barlow & Hersen, 1984, p. 253). In applied research, it may mean that an alternative treatment is provided every time a participant is seen (Barlow & Hersen, 1984).

Although a baseline phase is not required in an alternate treatments design, it can strengthen the conclusions drawn from this design and should be included when possible (Cooper et al., 2007; Zhan & Ottenbacher, 2001). As Cooper et al. (2007) note, the inclusion of a baseline phase allows predicting the data points in the control condition of the alternating treatments phase as well as accomplishing verification of effect by demonstrating that the level of performance during the baseline remained unchanged with the introduction of the intervention. Also, the baseline phase allows comparing the behavior change produced by different conditions/treatments with the typical level of behavior uninfluenced by the intervention (Cooper et al., 2007).

An alternating treatments design controls for most threats against internal validity, including selection, history, and maturation (i.e., the same participants receive both treatments/conditions). Additionally, the initial baseline phase helps to control for regression to the mean as well as for testing effects, which constitute a particular threat in designs with repeated measures/assessments. A clear change in the level and/or slope of the target behavior with manipulations of the condition/treatment provides further evidence that repeated testing/measurements do not impact the dependent variable in an alternating treatments design.

Alternating treatments designs also have several advantages over other applied behavior analysis designs, including the following: (a) do not require withdrawal of the treatment like in reversal designs to demonstrate a functional relationship between the independent variable and the target behavior, (b) useful results from the comparison of two treatments or conditions can be obtained within a relatively short period of time relative to reversal or multiple baseline designs, and (c) can be used with unstable/variable data (Barlow & Hersen, 1984; Cooper et al., 2007).

Conditions, phases, and number of data points. The two conditions compared for this study included a non-treatment (no before-school program) and a treatment condition. The two phases (i.e., baseline and alternating treatments) lasted about two and five weeks, respectively, although the number of data points collected was different at each school. The data collection schedule can be found in Table 2 in Appendix B.

As can be observed in Table 2 in Appendix B, the baseline phase included five data points (i.e., a whole week) for school A and 10 data points (i.e., two weeks) for school B. Although baseline measures are typically collected until stability or counterfactual is obtained, practical considerations (i.e., predetermined starting day for the programs, limited duration of the programs, natural school breaks, and availability of resources) limited the capability to collect data for an undetermined period of time during the baseline phase. However, it was expected that the combination of the baseline and alternating treatments phase would be adequate to reveal potential condition differences.

During the alternating treatments phase, at school A, five data points were collected for each condition (one data point per condition each week), resulting in a total of 10 data points. At school B, data were collected daily for the duration of this phase (i.e., five weeks), resulting in a total of 23 data points (each week included two treatment data points and three non-treatment data points, except for weeks with holidays and/or field trips). The decision for the number of data points for this phase was based on the minimum number of data points required (i.e., two for each condition; Barlow & Hersen, 1984) and the practical considerations mentioned above.

Condition sequencing and discrete conditions. In alternating treatments designs, researchers must consider the issue of multiple treatment interference (i.e., would the effects be the same if each condition was implemented alone), which is related to the issues of sequential confounding or order effects (i.e., the order of conditions/treatments may influence their effects on the target behavior) and carryover effects (i.e., the influence of one treatment on an adjacent treatment, regardless of overall sequencing). However, counterbalancing the order of treatments (randomly or semi-randomly) can control for order effects and counterbalancing along with ensuring clearly discrete conditions/treatments can minimize carryover effects (Barlow & Hersen, 1984).

The fact that the before-school program for each school occurred on specific days of the week did not allow counterbalancing the no-treatment and treatment conditions in a random fashion. Such limitations are not unusual when conducting research in school settings. However, in the case of school A, the no-treatment data points were manipulated so they occurred both on days before and on days after the treatment data points (at least two times before and two times after). At school B, the treatment data points occurred both before and after non-treatment data points every week since the program took place on Tuesdays and Thursdays. Additionally, the two conditions (i.e., no-treatment vs. treatment) used in the study were clearly discrete, which helps control for potential order effects and minimize possible carryover effects.

Intervention: Before-School Physical Activity Program

The before-school program in both schools involved a running/walking club that took place two times a week (Tuesdays and Thursdays). For the purposes of this study, students were considered to have participated in the before-school program if they had accumulated at least five minutes of moderate-to-vigorous physical activity (MVPA). The next paragraphs include a brief description of the two before-school programs.

School A. At School A, the program lasted 20 minutes, from 7:50-8:10 am, and classes officially started at 8:20 am. On days without the program, students typically arrived to school between 8:00 and 8:20, which was considered homeroom time during which students got ready and completed morning work.

At this school, the physical education teacher used a reinforcement system, according to which students were rewarded for their participation in the program. The teacher monitored the distance the students covered within the program (seven laps equaled a mile) and the students received “shoe” shaped tokens for their shoestrings or backpacks every five miles they covered.

School B. At School B, the program lasted 15 minutes, from 7:20-7:35 am, and classes officially started at 8:00 am. At this school, students were not allowed on the school campus before 7:20, the first bell rang at 7:35 am, and students from each class lined up outside and waited for their teachers to take them inside. Similarly to School A, the period between 7:40 and 8:00 was considered homeroom time during which students got ready and completed morning work.

The physical teacher at this school also used a reinforcement system to reward students for their participation in the program. Specifically, students received a pencil for each two laps they completed as well as a “caught being good” ticket (part of the school accountability system) each time they participated in the program.

Data Collection & Procedures

University Institutional Review Board approval (see Appendix A) as well as district and principal approval were obtained prior to the beginning of the study. Also, student assent and parental consent forms were distributed and collected prior to data collection. Data collection occurred between late October and the middle of December of 2013 for School A and between the middle of January and late February of 2014 for School B. Data were collected on the following: (a) physical activity (i.e., target behavior), and (b) anthropometric measures (i.e., height and weight).

Physical activity. Steps and time spent in moderate-to vigorous physical activity (MVPA) were assessed during: (a) the running/walking club and (b) the school day. For the purposes of the running/walking club, steps and minutes were recorded right before students started running/walking as well as at the end of the before-school program or when they decided to discontinue participation. For school-day physical activity, steps and minutes were recorded at the beginning of homeroom time (8:00 am at School A and 7:40 am at School B) and the end of the school day.

Physical activity levels were measured using the *New Lifestyles NL-1000* pedometer, which uses a piezoelectric mechanism that is similar to accelerometers but less expensive. This instrument is set to record activity above 3.6 Metabolic Equivalents (METs) and uses a sampling interval of four seconds, which is suitable for children taking into account their sporadic physical activity patterns. The *NL-1000* has been shown to provide good estimates of physical activity in children (Hart, Brusseau, Kulinna, McClain, & Tudor-Locke, 2011; McMinn, Rowe, Stark, & Nicol, 2010).

Prior to the beginning of data collection, students were instructed how to use the *NL-1000* and had the opportunity to use it during two physical education lessons. Visuals that were posted in the gymnasium as well as in the homerooms of participating classes also served to remind students where to place their pedometer, how to reset it, and how to change the mode (i.e., step, minutes). Proper placement of the instrument was on the right hip in line with the midline of the thigh. Elastic belts were also available for students who had a difficult time adjusting the pedometer on their attire.

Pedometers were coded by color and number so that each class had a different color and each student was assigned a specific number and used the same pedometer throughout the study. Shake tests for the pedometers were conducted prior to the beginning of the study as well as every two weeks throughout the study.

Anthropometric measures. Height (in meters) and weight (in kilograms) measurements were obtained without shoes and heavy clothing using a calibrated digital scale (Seca 882 Digital BMI Scale) and stadiometer (Seca 214 Portable Stadiometer). These measurements were taken during the first two weeks of the study at each school and were used to calculate students' Body Mass Index (BMI) [weight (kg)/height (m) squared] and BMI-for-age percentile using CDC's BMI tool for schools (http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/tool_for_schools.html). Consequently, BMI-for-age percentiles were used to classify students as normal-weight (<85th percentile) or overweight/obese (≥85th percentile) based on CDC'S BMI-for-age growth charts for boys and girls (http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html).

Data Analysis

Physical activity was assessed during the before-school programs and across the school day to determine the influence of the programs on physical activity and potential compensation effects. All analyses were performed for both steps and MVPA time, and were conducted within a multilevel modeling framework with daily observations as level 1 variable (represented in equations by subscript i) and person-level variables (e.g., sex and BMI classification) as level-2 variables (represented in equations by subscript j). Analyses were conducted separately for each school since the purpose of the study was not to compare the two schools but rather to replicate the study in two different settings.

For the purposes of quantifying the magnitude or strength of potential effects (i.e., effect size), the *pseudo-*R^2 (Raudenbush & Bryk, 2002; Singer & Willett, 2003) was calculated, which is interpreted as the proportion reduction in variance for a parameter estimate that results from comparing the variance component (i.e., residual or level-1 variance, intercept or level-2 variance) in a baseline model to the same variance component in a fuller model (i.e., a model with more/all predictor variables). This statistic, which can only be interpreted as the value of one model relative to another model (and not as an explanation of the absolute amount of variance), is analogous to the R^2 statistic in multiple regression and is estimated through the formula

$$Pseudo - R^2 = \frac{(\sigma^2_{BASE} - \sigma^2_{FULL})}{\sigma^2_{BASE}}$$

where σ^2_{BASE} is the estimated variance (i.e., variability) for the dependent variable in the baseline or comparison model and σ^2_{FULL} is the estimated variance for the dependent variable in the full or fitted model. For the purposes of interpreting *pseudo-*R^2 values, Cohen's (1988) criteria for R^2 values were used, according to which values .02, .13, and .26 represent small, medium, and strong effects, respectively.

For example, for the purpose of determining the effect size when comparing a model with no predictors (i.e., baseline model) with a model with treatment (level-1 variable) as a predictor (full model), the residual or level-1 variance component would need to be used in the above formula. However, for the purpose of determining the proportion reduction in variance when comparing a baseline model with a full model that includes a level-2 or person-level variable (e.g., sex), the intercept or level-2 variance component would need to be used in the above formula. In the first case, the proportion reduction in variance refers to day-to-day variance in the dependent variable, whereas in the second case, it refers to variance in average/mean values of the dependent variable.

Running/walking club physical activity. To determine the mean number of steps and MVPA time accumulated within the running/walking club (first research question), an unconditional model (i.e., a model with no predictors) was tested

$$y_{ij} = B_0 + u_{0j} + e_{ij} \qquad (1).$$

In the above model, B_0 represents the mean values of the dependent variable, u_{0j} reflects variation in dependent variable means across students (i.e., between-person variance) and e_{ij} is left-over variability across observations (i.e., within-person variance).

Subsequently, to examine the influence of sex and BMI status on average physical activity levels (second and third research questions), the following model was tested

$$y_{ij} = B_0 + B_1\,(\text{sex}_j) + B_2\,(\text{BMIstatus}_j) + B_3\,(\text{grade level}) + u_{0j} + e_{ij} \qquad (2).$$

In this model, B_0 is the expected dependent variable (i.e., steps or MVPA) value when sex=0 (i.e., boys), BMIstatus=0 (i.e., normal weight), and grade level=0 (i.e., third grade). The coefficients B_1, B_2, and B_3 are partial regression coefficients, indicating the effect of each variable on average steps or MVPA when controlling for the other variables. Grade level was included in the model to control for potential grade level differences.

School-day physical activity. To examine the mean number of steps and activity minutes accumulated during the school day throughout the study (first research question) as well as examine the influence of sex and BMI status on average physical activity levels (second and third research question), the same analyses were conducted as above.

Compensatory effects. To determine whether students compensated on days they participated in the before-school program by engaging in reduced physical activity during the school day (fourth research question), analyses involved the testing of a random intercept model,

$$y_{ij} = B_0 + B_1 \, (\text{treatment}_{ij}) + u_{0j} + e_{ij} \tag{3}$$

that allows intercepts (i.e., mean steps of MVPA time) to vary across individual students but assumes constant slopes (i.e., same influence of treatment). In this model, B_0 reflects the expected number of steps or MVPA time in the absence of treatment (treatment=0), B_1 is the change in school-day physical activity for 1-unit change in treatment (i.e., participation in the before-school program), u_{0j} reflects variation in physical activity means across students, and e_{ij} is left-over variability not captured by the treatment.

Building towards this model, some preliminary analyses were conducted. These analyses included testing for the influence of the variables of physical education and extra recess (School B only) on day-to-day physical activity,

$$y_{ij} = B_0 + B_1 \, (\text{PE}_{ij}) + B_2 \, (\text{extra recess}_{ij}) \;\; u_{0j} + e_{ij} \tag{4}$$

to determine if they needed to be included in subsequent models. Preliminary analyses also included testing for potential effects of the design-based confounding variables of phase and order on day-to-day physical activity over and above treatment, to determine if they needed to be included as covariates in subsequent models. These two variables were tested in separate models because order was only present during the alternating treatments phase. For instance, the equation for the model including phase was:

$$y_{ij} = B_0 + B_1\,(\text{treatment}_{ij}) + B_2\,(\text{phase}_{ij}) + u_{0j} + e_{ij} \qquad (5).$$

Subsequently, the variables of sex, BMI status, and grade level were included in the resulting model. The purpose of this was to determine the contribution of treatment to school-day physical activity when controlling for these variables as well.

Following the preliminary analyses and the testing of the random intercept model, a random slope model was also tested

$$y_{ij} = B_0 + B_1\,(\text{treatment}_{ij}) + b_1\,(\text{treatment}_{ij}) + u_{0j} + e_{ij} \qquad (6).$$

that allows both intercepts (i.e., mean steps or MVPA time) and slopes (i.e., treatment effect) to vary across individual students. In this model, B_1 reflects the average treatment effect on school-day physical activity and b_1 captures the possibility that the magnitude of the treatment effect varies across students. To evaluate the contribution of this model over the baseline model with no random slope, a likelihood ratio test was used. This test is more appropriate than the z test of the slope variance because it does not assume a random sampling distribution for variance (Raudenbush & Bryk, 2002). In this case, values of more than 5.99 (i.e., for two degrees of freedom difference and α=.05) indicate a better fit of the random slope model in comparison to the baseline model.

Results

As can be observed in Figure 1 in Appendix B, at school A, all students who volunteered to participate in the study attended the before-school program at least once and, thus, they were all included in the analyses. At School B, however, seven students did not attend the before-school program at all and were therefore excluded from related analyses. More detailed information about the frequency of participation in the two programs is available in Table 3 in Appendix B.

Running/Walking Club Physical Activity

Mean steps and MVPA time. Mean steps and MVPA minutes accumulated in the before-school program at each school are available in Table 1. The table also provides information regarding the percentage of program duration spent in MVPA, as well as the percentages of daily physical activity recommendations and school-day physical activity the before-school program steps and MVPA time represent. Mean running/walking club steps and MVPA minutes by school, grade level, and sex are presented in Table 2.

Sex and BMI differences. The results of the model with sex and BMI status as predictors and grade level as a covariate (see *Equation 2*) differed by school. As can be observed in Table 3, sex and BMI status did not significantly contribute to the prediction of average steps and MVPA time at School A when controlling for each other as well as grade level. At school B, however, sex significantly contributed to the prediction of steps and MVPA time over and above BMI status and grade level. Specifically, girls at school B accumulated significantly fewer steps (B_1= -438.97) and MVPA time (B_1= -2:36 minutes) within the running/walking club in comparison to boys. At the same time, BMI status was found to be a marginally significant (p=.05) predictor of average steps (but not MVPA time) at school B over and above sex and grade level, with overweight/obese students accumulating fewer steps (B_1= -221.76) than their normal-weight peers.

Pseudo-R^2 effect sizes for the School B models indicated .30 reduction in intercept variance for steps and .25 reduction in intercept variance for MVPA time (i.e., level-2 or intercept variance) when comparing the model with the set of predictors (sex, BMI status, and grade level) with the unconditional model (i.e., model with no predictors), both of which are considered large effect sizes. In other words, the addition of sex, BMI status, and grade level to the model with no predictors accounted for 30% and 25% of the variability in mean steps and MVPA time, respectively. Taking into account that sex was the only significant predictor, the proportion reduction of variance can be predominantly attributed to that specific variable.

School-Day Physical Activity

Mean steps and MVPA time. Mean steps and MVPA minutes accumulated during the school day at each school are available in Table 1. The table also provides information regarding: (a) the percentages of daily physical activity recommendations the school-day steps and MVPA time represent, and (b) the percentages of daily physical activity recommendations the combined school-day and before-school program steps and MVPA time represent. Mean school-day steps and MVPA minutes by school, grade level, and sex are presented in Table 4.

Sex and BMI differences. The results of the model with sex and BMI status as predictors and grade level as a covariate (see *Equation 2*) were similar for the two schools. As can be observed in Table 5, BMI status did not significantly contribute to the prediction of average steps or MVPA time at either school when controlling for sex and grade level. Sex, on the other hand, significantly contributed to the prediction of both average steps and MVPA time above and beyond BMI status and grade level at both schools. Specifically, girls accumulated significantly fewer steps (School A: B_1= -

1765.88; School B: B_1= -583.27) and MVPA time (School A: B_1= -9:13 minutes; School B: B_1= -4:17) during the school day in comparison to boys.

Pseudo-R^2 effect sizes for School A were .57 for steps and .63 for MVPA time. For School B, they were .40 for steps and .31 for MVPA time. These effect sizes represent proportion reduction in intercept or level-2 variance when comparing the model with the set of three predictors to the unconditional model and, based on Cohen's criteria, are all large effect sizes.

Compensatory Effects

Preliminary analyses related to physical education (for both schools) and extra recess (only for school B) (see *Equation 4*) indicated that both of these variables significantly contributed to the prediction of physical activity when controlling for each other. Additionally, preliminary analyses (see *Equation 5*) examining the design-based confounding variables of phase and order, indicated than only phase significantly contributed to student physical activity when controlling for treatment, physical education, and extra recess. (Estimates for these preliminary models can be found in Tables 4 and 5 in Appendix B). Therefore, the variables of physical education, extra recess (only for school B), and phase were included in subsequent models.

Consequently, the random intercept model was tested (see *Equation 3*) including the variables of treatment, physical education, extra recess (only for School B), and phase, as well as sex, BMI status, and grade level. The results of this model indicated that treatment did not significantly contribute to school-day steps or MVPA time over and above physical education and phase at School A (see Table 6), therefore suggesting a non-compensatory effect on days students participated in the before-school program. At

School B, however, treatment was found to significantly contribute to the prediction of both school-day steps and MVPA time when controlling for physical education, extra recess, and phase, as well as sex, BMI status, and grade level. Specifically, students at School B accumulated a significantly greater number of steps (B_1= 331.46) and MVPA time (B_1= 1:26 minutes) on days they participated in the before school program. However, the magnitude of this effect was small (*pseudo*-R^2=.02 for both steps and MVPA).

Next, a model was tested that included a random slope for treatment (see *Equation 6*). This model did not converge for either steps or MVPA time at School A, even when the number of iterations was increased, possibly indicating inadequate information for the addition of a random slope (Singer & Willett, 2003) and suggesting a uniform impact of the treatment across participants. However, the likelihood ratio tests for School B indicated a better fit of the random slope model in comparison to the random intercept model, both for steps ($\chi^2(2)$=18.37, $p<.001$) and MVPA time ($\chi^2(2)$=22.46, $p<.001$). Based on the results of the random slope model, therefore, the association between treatment and school-day physical activity at School 2 differed across participants. On average, the person-specific treatment slopes differed from the average treatment slope by 481.37 steps, 95% CI [-603, 1284], and 1:54 minutes, 95% CI [-3:57, 6:56], suggesting that some children compensated by engaging in reduced physical activity during the school day, whereas others engaged in increased school-day physical activity on days they attended the before-school program. Also, although insignificant ($p>.05$), the intercept-slope correlations were moderately positive (r=.34 for steps and r=.36 for MVPA time), indicating that the difference in steps and MVPA time on days with the treatment was moderately higher for children with higher average school-day steps and MVPA time on days without the treatment.

Discussion

This study aimed to examine: (a) children's physical activity levels during a before-school running/walking club as well as during the school day, (b) sex and BMI status differences in physical activity levels, and (c) whether children compensate for the physical activity they receive in the running/walking club by being less active during the rest of the school day. For the purposes of this study, data were collected from two different schools. Data analysis was conducted separately for each school since the study's purpose was not to compare the two schools but rather to examine the impact of the before-school program on children's physical activity levels in two different settings.

Running/walking club results indicated that children accumulated substantial amounts of physical activity in the before-school program (1731 steps and 10:02 MVPA minutes at School A; 1502 steps and 8:30 MVPA minutes at School B). The activity levels accumulated within both programs, whose duration was 20 minutes for School A and 15 minutes for School B, met or exceeded the standard of 50% of before-school program time spent in MVPA (50% at School A and 56.67% at School B), as identified in the CSPAP Policy Continuum document (NASPE, 2012). These results are comparable to the results of Mahar et al. (2011), the only other study identified that focused on a before-school program and used an objective measure of physical activity, who found that children spent an average of 46.4% (9.3 minutes) of their time present in the program in MVPA.

The amounts of physical activity accumulated through the before-school programs at the two schools represent substantial portions of the daily physical activity recommendations (14.43% and 12.52% of the daily step recommendations for Schools A and B, respectively; 16.72% and 14.17% of the daily MVPA recommendations for Schools A and B, respectively). The importance of these numbers lies in the fact that the duration of these programs was only 20 and 15 minutes.

The significance of these amounts of physical activity is further highlighted when considered relative to the school-day physical activity levels (excluding the before-school program physical activity) of children at the two schools. At School A, the running/walking club physical activity of children represented about 28.41% and 44.44% of their school-day steps and MVPA time, respectively. Similarly, the before-school program physical activity of children at School B represented about 33.2% and 46.83% of their school-day steps and MVPA time, respectively. Moreover, when adding the before-school program physical activity levels to those of the school day (see Table 1), it is clear that the running/walking club has the potential to help children meet and or exceed the daily physical activity recommendations.

These findings should also be considered in light of the current realities of schools. Schools have been identified as ideal physical activity promotion sites (e.g., IOM, 2013, Pate et al., 2006) but, at the same time, physical education and recess have decreased across the nation over the last few years due to the increased focus on academic performance (Center on Education Policy, 2007). The two schools that participated in this study provided their students with daily recess but only two periods of physical education each week. Additionally, active commuting to/from school was minimal at School A, whereas only about 20% of the participants from School B reported actively commuting to school either occasionally or systematically. It is not surprising, therefore, that the before-school running/walking club was a significant source of these children's daily physical activity.

The fact that children at both schools accumulated significant amounts of physical activity during the before-school program did not lead to an overall compensation effect in terms of school-day physical activity levels. In other words, as a group, children did not engage in less physical activity during the school day on days they participated in the before-school program. Although children at School A seemed to accumulate 169 less steps and 00:14 less MVPA minutes on running/walking club days, this decrease was not statistically significant. On the other hand, although there was a small and statistically significant (p<.001) increase in the physical activity children at School B accumulated on days they attended the before-school program (331.46 steps, 01:16 MVPA minutes), the magnitude of this effect was small.

At the same time, analyses for School B also revealed individual differences in school-day physical activity compensation on running/walking club days, suggesting that some students may compensate by reducing their levels of physical activity during the school day, while others may actually engage in increased steps, 95% CI [-602.79, 1284.19], and MVPA time, 95% CI [-3:57, 6:56]. The intercept-slope correlations of r=.34 for steps and r=.36 for MVPA time, although insignificant, suggest that the difference in physical activity on before-school program days may be moderately higher in students that are more active during regular days.

These results are, for the most part, similar to the results of previous studies that investigated compensatory effects relative to school-based physical activity opportunities. Mahar et al. (2011), who also focused on a before-school program, found no significant differences in school-day physical activity (not including before-school program activity) on days children attended the before-school program. Similarly, other studies found that youth do not compensate for increased school-based physical activity opportunities by decreasing their after school or daily physical activity (Alderman et al., 2012; Dale et al., 2000; Morgan et al., 2007). Further, the results of some studies indicate that, overall, children engage in more after-school and daily physical activity on days with increased school-based physical activity opportunities (Alderman et al., 2012; Dale et al., 2000; Long et al., 2013).

Contrary to the finding that children of low, moderate, and high activity groups all engage in increased physical activity on days with increased school-based physical activity opportunities (Alderman et al., 2012), Morgan et al. (2007) found that only the most active group of children in their study accumulated significantly more daily steps on school days with increased physical activity programming. Also, in perhaps the only study that identified a compensation effect, Gidlow et al. (2008) found that some youth with the lowest in-school physical activity compensated by engaging in decreased physical activity out of school during the week and on the weekend. Together, these findings seem to lend support to the present study's finding that some children may engage in increased physical activity on days they attend the before-school program while some others may compensate by reducing their spontaneous physical activity. At the same time, these findings point out the need for further investigation of the compensation question as a function of overall activity levels (i.e., high, moderate, low).

This study also examined BMI status and sex differences for children's physical activity, both during the before-school program and the school day. In terms of BMI status, only one marginally significant (p=.05) difference emerged, with overweight/ obese children at School B taking, on average, 222 fewer steps than their normal-weight peers when controlling for sex and grade level. The lack of BMI differences may be due to: (a) combining overweight and obese children in one category (due to the relatively small sample size), and (b) not obtaining a separate estimate for vigorous physical activity time. Related studies suggest that body fat measures but not BMI are associated with physical activity in children and adolescents (Abbott & Davies, 2004; Rennie et al., 2005), as well as that body fat correlates with vigorous but not moderate physical activity (Abbott & Davies, 2004; Gutin, Yin, Humphries, & Barbeau, 2005).

Sex differences were found for physical activity levels both during the before-school program and the school day when controlling for BMI and grade level. In terms of the running/walking club, significant sex differences were only found for School B, with boys engaging in significantly more steps (439; p<.001) and MVPA minutes (2:36; p<.01) than girls. Although sex differences in physical activity are often reported in the literature, this finding should be interpreted with caution since children arrived at the before-school program at different times and, therefore, these differences may be reflective of this rather than actual differences in physical activity engagement while at the program. In another study that looked at a before-school program, Stylianou et al.

(2014) also found sex differences, with boys covering significantly longer average daily distances than girls. However, most descriptive studies that looked at the before-school segment of the day found no significant sex differences in children's physical activity levels (Fairclough et al., 2008, 2012; McKenzie et al., 2010; Tudor-Locke et al., 2006), whereas one study did (McKenzie et al., 2000).

Sex differences were also found for school-day physical activity levels in both schools, again with boys engaging in significantly more steps (School A=1766, $p<.001$; School B=583, $p=.01$) and MVPA minutes (School A=09:13, $p<.001$; School B=04:17, $p<.01$) than girls. Such differences are common in the literature (e.g., Troiano et al., 2008; Trost et al., 2002) and highlight the need to pay particular attention to female students' physical activity patterns from a young age.

Strengths and Limitations

The strengths of this study include its design, which combined a baseline phase with an alternating treatments phase, thus controlling against threats to internal validity. Another strength of the study is the replication of the project in a second setting, which provides support both for internal and external validity. At the same time, however, additional studies are needed to support the generalizability of this study's results to other settings.

The limitations of the study include the fact that the exact time of participation in the before-school program was not monitored (i.e., arrival and departure times). Another limitation is that the physical education teachers facilitating the two before-school programs used reinforcement systems and rewarded children for their participation in the running/walking club. Future studies should attempt to replicate the results of this study without the use of reinforcement and/or should manipulate reinforcement to examine its effects on program participation and children's physical activity levels.

Conclusion and Recommendations for Future Research

The findings of this study indicate that a before-school running/walking program can significantly contribute to children's physical activity levels and can help them meet the daily recommendations for physical activity. Walking and running are lifetime physical activities that generate important health benefits and a running/walking program is simple and cost-effective. Additionally, the results of this study suggest that, overall, students do not compensate for the physical activity they accumulate in the before-school program by decreasing their school-day physical activity.

Before-school programs may be the least studied student-related component of CSPAPs. Thus, it is recommended that additional studies focus on various types of before-school programs (e.g., structured vs. unstructured) and examine resulting participation rates, physical activity levels, as well as potential sex differences. Finally, it is also recommended to investigate other outcomes relative to participation in before school programs, including school attendance, students' classroom behavior, and cognitive or academic performance.

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Table 1

Running/walking Club and School-Day Physical Activity Levels by School

	Running/Walking Club Steps				
	Mean	Within-Person *SD*	Between-Person *SD*	% of Daily Step Recommendations	% of School-Day Steps
School A	1731	567	473	14.43	28.41
School B	1502	372	341	12.52	33.20

	Running/Walking Club MVPA Time (minutes)					
	Mean	Within-Person *SD*	Between-Person *SD*	% of Program Duration	% of Daily MVPA Recommendations	% of School-Day MVPA
School A	10:02	3:20	2:59	50.00	16.72	44.44
School B	08:30	2:24	2:07	56.67	14.17	46.83

	School-Day Steps				
	Mean	Within-Person *SD*	Between-Person *SD*	% of Daily Step Recommendations	% of Daily Step Recommendations with RWC Steps
School A	6090	1372	1358	50.74	65.17
School B	4524	1282	767	37.70	50.22

	School-Day MVPA Time (minutes)				
	Mean	Within-Person *SD*	Between-Person *SD*	% of Daily MVPA Recommendations	% of Daily MVPA Recommendations with RWC MVPA
School A	22:30	6:46	6:10	37.50	54.22
School B	18:29	6:41	4:23	30.81	44.97

Note. Daily Step Recommendation = 12000 steps (Colley, Janssen, & Tremblay, 2012); Daily MVPA Recommendation = 60 minutes (USDHHS, 2008); RWC = Running/walking Club.

Table 2

Running/Walking Club Physical Activity Levels by Grade Level and Sex

	School A					
	3rd Grade					
	Boys			Girls		
	Steps	MVPA (min)	% of Time	Steps	MVPA (min)	% of Time
Intercept (B_0)	2142	11:58	59.83	1544	9:27	47.25
Within-Person *SD*	733	04:22		414	2:53	
Between-Person *SD*	-	-		526	3:29	
	4th Grade					
	Boys			Girls		
	Steps	MVPA (min)	% of Time	Steps	MVPA (min)	% of Time
Intercept (B_0)	1795	10:10	50.83	1681	09:35	47.92
Within-Person *SD*	615	03:10		558	03:11	
Between-Person *SD*	563	03:48		452	02:55	

	School B					
	3rd Grade					
	Boys			Girls		
	Steps	MVPA (min)	% of Time	Steps	MVPA (min)	% of Time
Intercept (B_0)	1729	09:47	65.22	1228	06:48	45.33
Within-Person *SD*	372	02:23		321	01:38	
Between-Person *SD*	351	02:22		269	00:37	
	4th Grade					
	Boys			Girls		
	Steps	MVPA (min)	% of Time	Steps	MVPA (min)	% of Time
Intercept (B_0)	1514	08:40	57.78	1341	07:33	50.33
Within-Person *SD*	425	03:03		355	02:16	
Between-Person *SD*	295	01:24		169	01:26	

Table 3

Estimates for Running/Walking Club Physical Activity Models

	School A					
	Steps			MVPA (minutes)		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	1947	201	< .001	11:11	01:16	< .001
B_1 (Sex)	-289	202	.161	-01:19	01:16	.311
B_2 (BMI Status)	-66	226	.773	-00:16	01:25	.847
B_3 (Grade Level)	-25	193	.899	-00:27	01:13	.710
	School B					
	Steps			MVPA (minutes)		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	1795	91	< .001	10:03	00:35	< .001
B_1 (Sex)	-439	111	< .001	-02:36	00:43	< .010
B_2 (BMI Status)	-222	110	.050	-01:02	00:42	.150
B_3 (Grade Level)	-69	97	.481	-00:16	00:37	.679

Table 4

School-Day Physical Activity Levels by Grade Level and Sex

	School A 3rd Grade			
	Boys		Girls	
	Steps	MVPA (minutes)	Steps	MVPA (minutes)
Intercept (B_0)	8858	35:11	5891	20:44
Within-Person SD	1879	07:37	1446	06:53
Between-Person SD	1483	04:48	950	03:18
	4th Grade			
	Boys		Girls	
	Steps	MVPA (minutes)	Steps	MVPA (minutes)
Intercept (B_0)	6466	25:10	5217	18:39
Within-Person SD	1358	07:55	1160	05:49
Between-Person SD	510	02:19	694	02:57

	School B 3rd Grade			
	Boys		Girls	
	Steps	MVPA (minutes)	Steps	MVPA (minutes)
Intercept (B_0)	4319	17:56	3830	15:20
Within-Person SD	1339	06:58	1153	05:32
Between-Person SD	691	04:17	356	01:22
	4th Grade			
	Boys		Girls	
	Steps	MVPA (minutes)	Steps	MVPA (minutes)
Intercept (B_0)	5353	23:08	4470	16:52
Within-Person SD	1471	08:10	1069	05:11
Between-Person SD	620	03:29	534	03:07

Table 5

Estimates for School-Day Physical Activity Models

	School A					
	Steps			MVPA (minutes)		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	8079	351	< .001	32:11	01:35	< .001
B_1 (Sex)	-1766	337	< .001	-09:13	01:29	< .001
B_2 (BMI Status)	-553	364	.138	-02:44	01:35	.094
B_3 (Grade Level)	-1152	325	< .010	-04:38	01:26	< .010
	School B					
	Steps			MVPA (minutes)		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	4256	180	< .001	18:18	01:05	< .001
B_1 (Sex)	-583	216	.010	-04:17	01:18	< .010
B_2 (BMI Status)	-246	216	.260	-00:28	01:18	.716
B_3 (Grade Level)	852	189	< .001	03:37	01:08	< .010

Table 6

Estimates for School-Day Physical Activity Random Intercept Models

	School A					
	Steps			MVPA (minutes)		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	8205	340	< .001	32:11	01:34	< .001
B_1 (Treatment)	-169	155	.276	-00:14	00:48	.765
B_2 (PE)	1028	123	< .001	05:03	00:38	< .001
B_3 (Phase)	-585	132	< .001	-02:25	00:41	< .001
B_4 (Sex)	-1792	316	< .001	-09:59	01:25	< .001
B_5 (BMI Status)	-548	341	.117	-02:35	01:31	.099
B_6 (Grade Level)	-1204	304	< .001	-04:43	01:22	< .010
	School B					
	Steps			MVPA (minutes)		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	3404	189	< .001	14:25	01:07	< .001
B_1 (Treatment)	331	72	< .001	01:26	00:24	< .001
B_2 (PE)	1006	56	< .001	04:54	00:19	< .001
B_3 (Extra recess)	1959	80	< .001	09:06	00:26	< .001
B_4 (Phase)	208	63	< .010	00:48	00:21	.024
B_5 (Sex)	-624	219	< .010	-04:30	01:18	< .010
B_6 (BMI Status)	-184	219	.404	-00:12	01:18	.876
B_7 (Grade Level)	903	191	< .001	03:48	01:08	< .010

Chapter 4: A BEFORE-SCHOOL PHYSICAL ACTIVITY PROGRAM & STUDENT ON-TASK BEHAVIOR

The prevalence of childhood and adolescent obesity has tripled in the last few decades (Ogden & Carroll, 2010) and low levels of physical activity have been identified as a significant contributing factor (Brock et al., 2009; Jago, Baranowski, Thompson, Baranowski, & Greaves, 2005; Trost, Kerr, Ward, & Pate, 2001; Weinsier, Hunter, Heini, Goran, & Sells, 1998). Schools have been identified as primary sites for promoting physical activity (e.g., Institute of Medicine, 2013; Pate et al., 2006) because the vast majority of school-aged youth attend school. Furthermore, facilities and equipment are available as well as qualified personnel who can facilitate and supervise physical activity opportunities. However, despite the fact that schools are ideal sites for physical activity promotion, most of the time children and adolescents spend in school is sedentary in nature and, in addition, physical activity opportunities in U.S. schools (i.e., physical education and recess) have decreased as a result of the current economic conditions and the heavy emphasis on improving academic performance (e.g., Center on Education Policy, 2007; Hardman, 2007).

Beyond the extensive health benefits of physical activity, which have long been established, there is now a body of literature suggesting that school physical activity opportunities may also improve students' classroom behavior, cognition, and academic achievement. The last couple of decades there has been increased research activity in this area and several review studies have been conducted to determine the impact of physical activity on various measures related to school performance and cognitive health.

For example, Sibley and Etnier (2003) conducted a meta-analytic review on the relationship between physical activity and cognition in children and found a significant positive relationship between the two, with an effect size of 0.32. Additionally, a qualitative review conducted by the Centers of Disease Control and Prevention (CDC, 2010) indicated that physical activity may help, but does not adversely impact direct or indirect measures of academic performance, including academic achievement, academic behavior, and cognitive skills and attitudes (50.5% positive, 48% insignificant, and only 1.5% negative associations). Further, in another review study, Mahar (2011) found small to moderate improvements on elementary school students' attention-to-task following short bouts of physical activity, with effect sizes typically ranging from 0.13 to 0.60.

Further research in this area "is needed to justify the incorporation of physical activity in school settings, especially to teachers and administrators" (Mahar et al., 2006, p. 2086), who are currently caught in the middle of the clash between education objectives and public health goals, two major national agendas in the U.S. (O'Sullivan, 2004). Indeed, although teachers and administrators are aware of the health benefits of physical activity, they may be hesitant to increase physical activity time throughout the school day take because of the pressures they receive to improve academic performance (Cothran, Kulinna, & Garn, 2010). Demonstrating the cognitive and academic benefits of physical activity may alleviate some of their concerns and lead to additional physical activity opportunities throughout the school day.

Physical Activity and Classroom Behavior

An outcome that is often explored in association to school physical activity participation is classroom behavior. Similar to the definition provided in CDC's (2010) report for academic behaviors, classroom behavior includes various behaviors that may have an impact on student adjustment and academic performance. These behaviors may include social and work aspects of classroom behavior, time-on-task, time-off-task, misbehavior, fidgeting, and other related types of behavior. The literature review in this chapter provides an overview of studies that have examined such behaviors following different types of physical activity and is organized into three sections based on the type of physical activity employed in each study (i.e., recess, classroom physical activity, and before-school physical activity).

Classroom behavior following recess. Five studies could be identified that investigated the effects of recess on classroom behavior. Among these studies, one reported negative effects of recess and one reported mixed findings. Specifically, using direct observation, Pellegrini and Davis (1993), found that third grade children who were more active during recess were more restless in the classroom, but the correlations in this study were very weak (< .20). In the second study, using scan sampling (i.e., counting students who were off task), Pellegrini, Huberty, and Jones (1995) found that inattention-to-task rates were significantly lower after recess than before recess (mean differences ranged from 1.25% to 8.39%), both for outdoor and indoor recess, but only for some of the kindergarten, second, and fourth grade groups participating in the study.

The results of Jarrett et al. (1998), who evaluated classroom behavior using direct observation, indicated that fourth grade students' on-task behavior significantly increased (90% vs. 85%; Cohen's d = .51) and fidgety behavior significantly decreased (7% vs. 16%; Cohen's d = .94) on days with recess compared to days with no recess. Also, 60% of the participants in this study, including all five students with attention deficit disorder, were at least one standard error above the mean difference score on one or on both behaviors on days with recess.

Ridgway, Northup, Pellegrin, LaRue, and Hightshoe (2003), who evaluated the effects of recess on the classroom behavior of second grade boys with and without ADHD through direct observation, found that inappropriate behavior levels (including off-task behavior) decreased for participants in both groups on days with recess. However, greater effects were observed for most of the participants with ADHD (35%, 41%, and 15% improvement) than for the groups of participants without ADHD (16%, 22%, and 16% improvement).

Finally, the results of Barros, Silver, and Stein (2009), who used teachers' ratings of classroom behavior based on a 5-point scale, indicated that classroom behavior was significantly better for children with some recess (3.60 ± 0.85) than for those with no or minimal recess (3.44 ± 0.90) (Cohen's d = 0.18). Based on a second classification with five subcategories for 'some recess', no significant differences were found among the groups with different levels of exposure to recess.

Classroom behavior following classroom physical activity. Four studies could be identified that investigated the effects of classroom physical activity on classroom behavior and their findings are mixed. Two of the four studies found improvements in on-task behavior following short bouts of physical activity in the classroom. Specifically, classroom observations in the Mahar et al. (2006) study revealed a significant improvement of over 8% in third and fourth grade students' on-task behavior from pre-Energizers to post-Energizers (70.9 ± 15.3 to 79.2 ± 11.4), which was of moderate effect (Cohen's d = 0.60). In addition, the authors found a stronger effect (Cohen's d = 2.20) for the least on-task students, who showed an improvement of 20% in on-task behavior from pre-Energizers to post-Energizers. Similarly, Goh, Hannon, Fu, and Prewitt (2012), who also evaluated on-task behavior using direct observation, found a statistically significant improvement of 5% in third to fifth grade students' on-task behavior between pre-active and post-active lessons.

Contrary to the results of the above two studies, Grieco, Jowers, and Bartholomew (2009), who examined the effects of a physically active classroom lesson and body mass index (BMI) category on third grade students' time-on-task through direct observation, found small, non-significant improvements in time-on-task following the active lesson for students of all BMI categories. However, Grieco et al. (2009) found significant decreases in time-on-task for students in all BMI categories following the inactive control lesson. Specifically, an inverse relationship was found between BMI and time-on-task after the inactive lesson, with overweight (26.5% decrease; Cohen's d = -1.28) and at risk for overweight (13.6% decrease; Cohen's d = -0.68) participants demonstrating greater decreases than normal weight participants (7.4% decrease; Cohen's d = -0.39). Finally, Katz et al. (2010) found no significant differences in the classroom behavior of second, third, and fourth students as measured by the district's work/social skills progress report.

Classroom behavior following before-school programs. One study could be identified that investigated the effects of a before-school program on classroom behavior (Mahar, Vuchenich, Golden, DuBose, & Raedeke, 2011). This study used a 30-minute before-school program that included sport-specific skills, dance, circuit, and other activities. In this study, third grade students' on-task behavior was assessed via direct observation. Findings indicated that on-task behavior significantly increased from baseline (61%) to intervention (79%) (Cohen's d = 1.17), as well as that it significantly decreased from intervention (79%) to post-intervention (64%) (Cohen's d = 0.95).

Classroom behavior evaluation. The aforementioned studies employed different ways of assessing classroom behavior. For example, some of the studies used classroom teacher ratings of classroom behavior based on various scales (Barros et al., 2009; Katz et al., 2010). However, the majority of the studies used direct observation to evaluate classroom behavior (Goh et al., 2012; Grieco et al., 2009; Jarrett et al., 1998; Mahar et al., 2006, 2011; Pellegrini & Davis, 1993; Pellegrini et al., 1995; Ridgway et al., 2003). Also, several studies focused on measures related to classroom work, particularly on-task and off-task behavior (Goh et al., 2012; Grieco et al., 2009; Jarrett et al., 1998; Mahar et al., 2006, 2011; Ridgway et al., 2003).

Physical Activity and On-task Behavior: Potential Underlying Mechanisms

A potential explanation for the positive relationship between physical activity and on-task behavior lies on the effects of acute physical activity on cognitive processes. Cognitive processes are a result of brain activity, which is influenced, among other factors, by brain anatomy and physiology. "The human brain is composed of very complex neural circuits bathed in a variety of chemicals that can regulate and modulate function" (Johnson & de Haan, 2011, p. 8) and, therefore, physiological changes as a result of physical activity are thought to influence cognitive processes.

Accordingly, several physiological mechanisms have been proposed to explain changes in cognitive processes following acute bouts of (predominantly aerobic) physical activity. One of these mechanisms relates to increases in cerebral blood flow as a result of exercise (Querido & Sheel, 2007). A second mechanism relates to the several biochemical substances (e.g., neurotransmitters like dopamine and serotonin, and neurotrophins and growth factors like brain-derived neurotrophic factor and insulin growth factor-1) produced by exercise (Chaouloff, 1997; Diamond, Briand, Fossella, & Gehlbach, 2004; Russo-Neustadt, Ha, Ramirez, & Kesslak, 2001; Vaynman & Gomez-Pinilla, 2005). Finally, a third mechanism relates to a more general arousal mechanism, according to which acute bouts of exercise stimulate the organism in a general manner leading to changes in cognitive functioning (Kamijo et al., 2004; Polich & Kok, 1995).

Acute physical activity is thought to facilitate children's executive functioning (Tomporowski, Davis, Miller, & Naglieri, 2008), which involves several processes (i.e., response inhibition or self control, interference control - selective attention and cognitive inhibition, working memory, and cognitive flexibility) that, among other functions, make it possible to stay focused (Diamond, 2013). Children who are having difficulties with executive functioning processes are less likely to be able to stay on task in the classroom and succeed academically (St Clair-Thompson & Gathercole, 2006). Several studies have shown that acute bouts of physical activity positively influence students' executive functioning. For example, Kubesch et al. (2009) found that 7th grade German students' inhibitory attention significantly improved after a 30-minute PE lesson. Similarly, Hillman et al. (2009) found that a single, acute 20-minute bout of moderate exercise (i.e., walking) improved preadolescent students' cognitive control of attention. It is likely, therefore, that improvements in executive functioning processes mediate the effects of physical activity on on-task behavior.

Purpose

Given the potential of before-school programs to improve students' readiness to learn without taking time away from academics and the scarcity of studies that investigated this relationship, the purpose of this study was to examine the effect of a before-school running club on elementary school children's on-task behavior during the first 45 minutes of instruction. Specifically, this study examined the following two research questions:

1. Does children's on-task behavior improve on days they participate in the running/walking club?
2. Are there any sex and BMI status differences in terms of on-task behavior following the running/walking club?

Methods

Participants and Settings

The participants for this study were third and fourth grade students (*N*=95) from two schools in the Southwestern U.S. The two schools were purposively selected because they were interested in participating in the study and represented two different settings (i.e., private vs. public). The goal was not to compare the two schools but rather to replicate the study across the two settings.

The target sample size was about 30-35 children from each school and it was calculated using a power analysis (power=.80, α=.05, medium effect size) and taking into account the possibility of dropout, absences, and inconsistent participation in the before-school running club. Although the effect sizes obtained in a similar study (Mahar et al., 2011) were large (Cohen's d = 1.17 and .95), it was preferred to use a more conservative effect size estimate in the power analysis for this study.

School A. The first school was a K-8 private, independent, and high achieving school. In fall 2013, when the study took place, the total enrollment of school A was 273 students (mainly Caucasian) and the average class size was 18 students. The teachers for the two third and two fourth grade classes who were invited to participate in the study reported their ethnic backgrounds as Caucasian and had a mean teaching experience of 11.5 years *(SD*=6.14 years; range: 4-17).

From this school, 40 third and fourth grade students initially returned their parental consent and assent forms in order to participate in the study. No students were excluded because of learning disabilities or neurological disorders (e.g., ADHD) related to the study measure; however, one third grade student dropped out during the first week of the study, resulting in a final sample of 39 participants (3rd grade=16, 4th grade=23; male=14, female=25), the majority of whom identified their ethnic background as Caucasian (*n*=35; 89.74%). About one quarter of the participants (*n*=10; 25.64%) were overweight or obese (mean BMI=16.97 kg/m^2; *SD*=2.90 kg/m^2). Detailed demographic information for the participants can be found in Table 1 in Appendix C.

School B. The second school was a K-6 public and average performing school (overall school performance of B for 2012-2013). Its total enrollment during spring of 2014, when the study took place, was 451 students (57.43% Caucasian, 33.92% Hispanic, 8.65% other) and the average class size was 30 students. Also, according to data from February 2014, 59.28% of the students in school B were eligible for free or reduced-price lunch. The teachers for the two third and two fourth grade classes who participated in the study reported their ethnic backgrounds as Caucasian (*n*=3) and Hispanic (*n*=1), and had a mean teaching experience of 21.75 years *(SD*=9.03 years; range: 10-31).

From this school, 57 third and fourth grade students initially returned their parental consent and assent forms in order to participate in the study. Eight of the third grade student volunteers had to attend the learning center every morning and, therefore, could not be observed. Additionally, two fourth grade students were excluded because of learning disabilities or neurological disorders (e.g., ADHD) related to the study measure, and another fourth grade student dropped out prior to the beginning of the study. Thus, the final sample of participants from School B was 46 students (3^{rd} grade=20, 4^{th} grade=26; male=24, female=22), who identified their ethnic background as Caucasian (*n*=26; 56.52%), Hispanic (*n*=14; 30.43%), or Other (*n*=6; 13.04%). About one third of the participants (*n*=16; 34.78%) were overweight or obese (mean BMI=18.45 kg/m^2; *SD*=3.88 kg/m^2). Detailed demographic information for the participants can be found in Table 1 in Appendix C.

Design

This study employed a two-phase experimental design with an initial baseline phase and an alternating treatments phase. The alternating treatments design involves the rapid alternation of two or more treatments or conditions (e.g., no treatment vs. treatment) while their impact on the target behavior is measured (Barlow & Hersen, 1984; Cooper, Heron, & Heward, 2007). Rapid, however, "does not necessarily mean rapid within a fixed period of time" (Barlow & Hersen, 1984, p. 253). In applied research, it may mean that an alternative treatment is provided every time a participant is seen (Barlow & Hersen, 1984).

Although a baseline phase is not required in an alternate treatments design, it can strengthen the conclusions drawn from this design and should be included when possible

(Cooper et al., 2007; Zhan & Ottenbacher, 2001). As Cooper et al. (2007) note, the inclusion of a baseline phase allows predicting the data points in the control condition of the alternating treatments phase as well as accomplishing verification of effect by demonstrating that the level of performance during the baseline remained unchanged with the introduction of the intervention. Also, the baseline phase allows comparing the behavior change produced by different conditions/treatments with the typical level of behavior uninfluenced by the intervention (Cooper et al., 2007).

An alternating treatments design controls for most threats against internal validity, including selection, history, and maturation (i.e., the same participants receive both treatments/conditions). Additionally, the initial baseline phase helps to control for regression to the mean as well as for testing effects, which constitute a particular threat in designs with repeated measures/assessments. A clear change in the level and/or slope of the target behavior with manipulations of the condition/treatment provides further evidence that repeated testing/measurements do not impact the dependent variable in an alternating treatments design.

Alternating treatments designs also have several advantages over other applied behavior analysis designs, including the following: (a) do not require withdrawal of the treatment like in reversal designs to demonstrate a functional relationship between the independent variable and the target behavior, (b) useful results from the comparison of two treatments or conditions can be obtained within a relatively short period of time relative to reversal or multiple baseline designs, and (c) can be used with unstable/variable data (Barlow & Hersen, 1984; Cooper et al., 2007).

Conditions, phases, & number of data points. For this study, the two conditions compared included a non-treatment (no before-school program) and a treatment condition. The two phases (i.e., baseline and alternating treatments) lasted about two and five weeks, respectively. A detailed description of the data collection schedule can be found in Table 2 in Appendix C.

The baseline phase for School A included five data points over a week (i.e., every day), whereas it included five data points over two weeks for School B. Although baseline measures are typically collected until stability or counterfactual is obtained, practical considerations (i.e., predetermined starting day for the before-school programs, limited duration of the programs, natural school breaks, and availability of resources) limited the capability to collect data for an undetermined period of time during the baseline phase. However, it was expected that the combination of the baseline and alternating treatments phase would be adequate to reveal potential condition differences.

During the alternating treatments phase, five data points were collected for each condition (10 total). According to Barlow and Hersen (1984), a minimum of two data points for each condition/treatment are necessary in alternating treatments designs in order be able to compare the conditions/treatments, but a higher number of data points is much more desirable. Again, the decision for the number of data points for this phase was based on the minimum number of data points required and the practical considerations mentioned above.

Condition sequencing & discrete conditions. In alternating treatments designs, researchers must consider the issue of multiple treatment interference (i.e., would the effects be the same if each condition was implemented alone), which is related to the issues of sequential confounding or order effects (i.e., the order of conditions/treatments may influence their effects on the target behavior) and carryover effects (i.e., the influence of one treatment on an adjacent treatment, regardless of overall sequencing). However, counterbalancing the order of treatments (randomly or semi-randomly) can control for order effects and counterbalancing along with ensuring clearly discrete conditions/treatments can minimize carryover effects (Barlow & Hersen, 1984).

The fact that the before-school program for each school occurred on specific days of the week did not allow counterbalancing the no-treatment and treatment conditions in a random fashion. Such limitations are not unusual when conducting research in school settings but, in this case, the no-treatment data points were manipulated so they occurred both on days before and on days after the treatment data points (at least two times before and two times after). This, combined with the fact that the two conditions (i.e., no-treatment vs. treatment) used in the study are clearly discrete, should be able to control for potential order effects and minimize possible carryover effects.

Before-School Physical Activity Program

The before-school program in both schools involved a running/walking club that took place two times a week (Tuesdays and Thursdays). For the purposes of this study, students were considered to have participated in the before-school program if they had accumulated at least five minutes of moderate-to-vigorous physical activity (MVPA). At School A, the program lasted 20 minutes, from 7:50-8:10 am, and classes officially started at 8:20 am. On days without the program, students typically arrived to school between 8:00 and 8:20, which was considered homeroom time during which students got ready and completed morning work. At School B, the program lasted 15 minutes, from

7:20-7:35 am, and classes officially started at 8:00 am. At this school, students were not allowed on the school campus before 7:20, and when the first bell rang at 7:35 am, students from each class lined up outside and waited for their teachers to take them inside. Similarly to School A, the period between 7:40 and 8:00 was considered homeroom time during which students got ready and completed morning work.

Data Collection & Procedures

University Institutional Review Board approval (see Appendix A), district, and principal approval was obtained prior to the beginning of the study. Also, student assent and parental consent forms were distributed and collected prior to data collection.

Data collection occurred between late October and the middle of December of 2013 for School A and between the middle of January and late February of 2014 for School B. Data were collected on the following: (a) physical activity, (b) anthropometric measures (i.e., height and weight), and (c) on-task behavior (target behavior).

Physical activity. Both steps and time spent in moderate-to vigorous physical activity (MVPA) during the running/walking club were assessed in this study. Steps and minutes were recorded right before students started running/walking as well as at the end of the before-school program or when students decided to discontinue participation. Physical activity levels were measured using the *New Lifestyles NL-1000* pedometer, which uses a piezoelectric mechanism that is similar to accelerometers but less expensive. This instrument is set to record activity above 3.6 Metabolic Equivalents (METs) and uses a sampling interval of four seconds, which is suitable for children taking into account their sporadic physical activity pattern. The *NL-1000* has been shown to provide good estimates of physical activity in children (Hart, Brusseau, Kulinna, McClain, & Tudor-Locke, 2011; McMinn, Rowe, Stark, & Nicol, 2010).

Anthropometric measures. Height (in meters) and weight (in kilograms) measurements were obtained without shoes and heavy clothing using a calibrated digital scale (Seca 882 Digital BMI Scale) and stadiometer (Seca 214 Portable Stadiometer). These measurements were taken during the two first weeks of the study at each school and were used to calculate students' Body Mass Index (BMI) [weight (kg)/height (m) squared] and BMI-for-age percentile using CDC's BMI tool for schools. Consequently, BMI-for-age percentiles were used to classify students as normal-weight or overweight/obese based on CDC'S BMI-for-age growth charts for boys and girls.

On-task Behavior. Students' behavior in the classroom was observed during the first period of the school day and was classified as either on-task or off-task according to Mahar et al.'s (2006) definitions. *On-task behavior* was defined as verbal or motor behavior that followed the class rules and was appropriate to the learning situation or academic activity assigned by the teacher (e.g., listening to teacher directions, working quietly at one's desk, responding to teacher questions, etc.). *Off-task behavior* was defined as any behavior that was not on task (i.e., broke the classroom rules and/or interrupted the learning situation) and was coded as motor off-task (i.e., gross motor responses), noise off-task (i.e., verbal noise and object noise), or passive/other off-task (e.g., cases of non-participation when participation is necessary, staring into space, etc.).

Observation system**.** The observation method employed was similar to the one used by Mahar et al. (2006) and Mahar et al. (2011). On a given day, students from each class were observed for the first class period of the day. Observers listened to an mp3 file via headphones, indicating when to observe and when to record. Observation and recording intervals lasted five seconds each. Each student was observed for one minute (i.e., six observation intervals) before the observer rotated to the next student to be observed. The rotation from student to student was repeated until each student had been observed for a total of three minutes (i.e., 18 observation intervals each), thus allowing the assessment of up to 10-13 students during each class period (45 minutes).

Interval duration choice. The short duration of the intervals (i.e., five seconds) was chosen to make the observers' decision/choice easier (i.e., the longer the interval, the higher the probability that more behaviors will occur) and therefore increase the reliability of the data. At the same time, shorter intervals also allow for observation of more intervals in a given amount of time.

On-task and off-task behavior recording. On-task behavior was coded using whole interval recording, according to which a student must be on-task throughout the entire interval in order for his/her behavior to be recorded as on-task. Off-task behavior was coded using partial interval recording, according to which if a student demonstrates off-task behavior at any point during the interval, his/her behavior will be recorded as off-task. According to Mahar (2011), "partial interval recording may result in higher values of on-task behavior than whole interval recording" and "partial interval recording appears to be more appropriate for disruptive behaviors (e.g., off-task behaviors) that occur for brief periods" (p. S61). The recording system adopted treats on-task and off task behavior as mutually exclusive. For a particular interval, behavior can be recorded either as on-task or as off-task but not as both.

Scoring. For scoring purposes, the three off-task behaviors (motor off-task, noise off-task, other or passive off-task) were grouped together at the end of each observation to provided one measure of off-task behavior. A student's score for a specific day and period of observation was a percentage calculated by summing the number of intervals in which each behavior (i.e., on-task, off-task) occurred during the total observation period, dividing by the total number of intervals (i.e., 18), and then multiplying by 100.

Observer training and inter-observer reliability. Two primary observers and one secondary observer were trained to assess classroom behavior. In both schools, each primary observer was responsible for the assessments of two classes (one in each grade level). Therefore, each primary observer assessed the same classes for both phases of the study. The secondary observer participated in at least 25% of all observations with the primary observers for the purpose of estimating inter-observer reliability. When the secondary observer was observing with one of the primary observers, both observers were using use the same prerecorded mp3 file simultaneously.

Before the study, all observers trained in observing and coding on-task and off-task behavior by watching videotapes and attending live classroom instruction. Training continued until the observers reached at least a 90% reliability level. Observers also practiced observations in the classrooms participating in the study for one week before beginning data collection to get familiarized with the setting and to minimize the potential for a reactivity effect on both teachers and students.

Data Analysis

Inter-observer reliability. The percentage of inter-observer reliability was calculated by dividing the number of intervals with common codes (i.e., agreement) by the total number of observation intervals and then multiplying by 100.

Visual analysis. To determine a functional (or causal) relationship between behavior and an intervention, researchers in Applied Behavior Analysis rely on visual analysis of graphically plotted data that represent behavior patterns over time across experimental conditions. Visual analysis is generally regarded as a more conservative means of analyzing data than statistical analysis. That is, changes in behavior between experimental conditions generally need to be more substantial for the researcher to conclude that the behavior change is significant. Consequently, one is less prone to commit a Type I error (i.e., claiming a significant behavior change [or difference] when, in fact there is none).

When analyzing graphic data visually, the main criteria used to determine experimental effects include: (a) number of data points within phases/conditions (more points per phase/condition is preferable), (b) variability within and between phases/conditions, (c) trends within and between phases/conditions, (d) data overlap between phases/conditions, (e) mean changes between phases/conditions, (f) immediacy of behavior change from one phase/condition to the next, (g) data path decay, (h) induction effects, (i) stability of baselines, and (j) counter-therapeutic baselines (Cooper et al., 2007; Parsonson & Bear, 1978).

Specific to data collected with an alternating treatments design (Cooper et al., 2007), an added analytical criterion is the distance between data paths that represent different conditions. Also, in the case of an alternating treatments design with a baseline phase, the baseline phase allows examining whether the baseline level of performance remained unchanged with the introduction of the treatment (i.e., verification effect) as well as comparing the behavior change produced by different conditions/treatments with the typical level of behavior uninfluenced by the intervention. In general, the greater the immediate change with the introduction of a new phase/condition, the larger the distance between data paths of different conditions, the lower the data overlap between phases/conditions, and the more desirable the trends of the data, the stronger the case for an experimental effect (i.e., a functional relationship).

For the purposes of this study, the unit of analysis was the grade level (i.e., groups of children as opposed to individual children). Thus, standard deviations are also included for each data point in final graphs.

The visual analysis process started by initially creating individual graphs of on-task behavior to test the extent to which student behavior followed a zero, decreasing, or increasing trend (i.e., “overall direction taken by a data path”, Cooper et al., 2007, p. 133) during the baseline phase. For the purposes of this study, where the desired effect with the introduction of the treatment would be an enhancement of on-task behavior, zero or negative trends during the baseline phase would be ideal (i.e., what is also called a “counter-therapeutic baseline”). Subsequently, graphs of on-task behavior were developed by phase and condition (for each grade level at each school), and were visually interpreted by examining (using the criteria above) whether average on-task behavior systematically increased on days the participants attended the before-school physical activity program.

Statistical analysis. To determine the impact of the before-school program on students’ on task-behavior, statistical analyses were performed within a multilevel modeling framework with daily observations as level 1 variable (represented in equations by subscript i) and person-level variables (e.g., sex and BMI classification) as level-2 variables (represented in equations by subscript j). Analyses were conducted separately for the two schools since the purpose of the study was not to compare the two schools but rather to replicate the study in two different settings. Also, analyses were conducted by individual grade level as well as for the two grade levels combined. When models were tested for both grade levels combined, grade level was also included as a covariate.

Effect size. For the purposes of quantifying the magnitude or strength of potential effects (i.e., effect size), the *pseudo*-R^2 (Raudenbush & Bryk, 2002; Singer & Willett, 2003) was calculated, which is interpreted as the proportion reduction in variance for a parameter estimate that results from comparing the variance component (i.e., residual or level-1 variance, intercept or level-2 variance) in a baseline model to the same variance component in a fuller model (i.e., a model with more/all predictor variables). This statistic, which can only be interpreted as the value of one model relative to another model (and not as an explanation of the absolute amount of variance), is analogous to the R^2 statistic in multiple regression and is estimated through the formula

$$Pseudo - R^2 = \frac{(\sigma^2_{BASE} - \sigma^2_{FULL})}{\sigma^2_{BASE}}$$

where σ^2_{BASE} is the estimated variance (i.e., variability) for the dependent variable in the baseline or comparison model and σ^2_{FULL} is the estimated variance for the dependent variable in the full or fitted model. For the purposes of interpreting *pseudo*-R^2 values, Cohen's (1988) criteria for R^2 values were used, according to which values .02, .13, and .26 represent small, medium, and strong effects, respectively.

For example, for the purpose of determining the proportion reduction in variance when comparing a model with no predictors (i.e., baseline model) with a model with treatment (level-1 variable) as a predictor (full model), the residual or level-1 variance component would need to be used in the above formula. However, for the purpose of determining the proportion reduction in variance when comparing a baseline model (e.g., a model with treatment as a predictor) with a full model that includes a level-2 or person-level variable (e.g., sex), the intercept or level-2 variance component would need to be used in the above formula. In the first case, the proportion reduction in variance refers to day-to-day variance in the dependent variable, whereas in the second case, it refers to variance in average/mean values of the dependent variable.

Models tested. Initially, a series of unconditional models (i.e., models with no predictors) were ran

$$y_{ij} = B_0 + u_{0j} + e_{ij} \tag{1}$$

to obtain mean values of on-task behavior by phase and condition. In the above model, B_0 represents the mean value of on-task behavior, u_{0j} reflects variation in on-task means across students (i.e., between-person variance) and e_{ij} is left-over variability across observations (i.e., within-person variance).

To examine the impact of the treatment on students' on-task behavior (primary research question), a random intercept model was tested

$$y_{ij} = B_0 + B_1\,(\text{treatment}_{ij}) + u_{0j} + e_{ij} \tag{2}$$

that allows intercepts (i.e., on-task behavior means) to vary across individual students but assumes constant slopes (i.e., same influence of treatment on on-task behavior). In the above model, B_0 represents the expected on-task behavior value in the absence of treatment (treatment=0), B_1 is the change in on-task behavior for 1-unit change in treatment (i.e., presence of treatment), u_{0j} reflects variation in on-task behavior means across students (i.e., residual term that deals with independence violations that result from having repeated measures from the same individuals), and e_{ij} is left-over variability not captured by the treatment.

Building towards the random intercept model (see Equation 2), some preliminary analyses were conducted. These analyses included testing for potential effects of the design-based confounding variables of phase and order (level-1 variables) on day-to-day on-task behavior over and above treatment, to determine if they needed to be included as covariates in subsequent models. These two variables were tested in separate models since order was only present in the alternating treatment phase. For instance, the equation for the model including phase was

$$y_{ij} = B_0 + B_1 (\text{treatment}_{ij}) + B_2 (\text{phase}_{ij}) + u_{0j} + e_{ij} \quad (3).$$

Continuing to address the primary research question, a random slope model

$$y_{ij} = B_0 + B_1 (\text{treatment}_{ij}) + b_1 (\text{treatment}_{ij}) + u_{0j} + e_{ij} \quad (4)$$

that allows both intercepts (i.e., on-task behavior means) and slopes (i.e., treatment effect) to vary across individual students was also tested. In this model, B_1 reflects the average treatment effect on on-task behavior and b_1 captures the possibility that the magnitude of the treatment effect varies across students.

Finally, to examine potential contributions of the person-level variables of sex and BMI status (normal weight vs. overweight/obese) in predicting average levels of on-task behavior following the treatment (second research question), two separate models were examined. Each model included sex and BMI status, as well as a product variable (i.e., interaction) - treatment*sex or treatment*BMIstatus. For example, the model with the product variable for sex and treatment was,

$$y_{ij} = B_0 + B_1 (\text{treatment}_{ij}) + B_2 (\text{sex}_j) + B_3 (\text{BMIstat}_j) + B_4 (\text{treatment}_{ij}\text{*sex}) + u_{0j} + e_{ij} \quad (5),$$

where B_0 represents the expected on-task behavior value when treatment=0 (i.e., no treatment), sex=0 (i.e., boys), BMI status=0 (i.e., normal weight), and treatment*sex=0 (i.e., no interaction). The coefficients B_1, B_2, B_3, and B_4 are partial regression coefficients, indicating the effect of each variable on average on-task behavior when controlling for the other variables.

Results

As can be observed in Figure 1 in Appendix C, at school A, all students who volunteered to participate in the study attended the before-school program at least once and, thus, they were all included in the analyses. At School B, however, eight students did not attend the before-school program on any day their grade level was observed and were therefore excluded from the analyses.

Inter-observer Reliability

For the purposes of establishing inter-observer reliability, the secondary observer participated in 25% and 30% of all observations in Schools A and B, respectively. The resulting inter-observer reliability rates were 91.5% for School A (range = 85-97.5%) and 92.25 for School B (range = 85.5-98%).

Visual Analysis

The individual graphs of on-task behavior during the baseline phase revealed that the behavior of over 80% of participants at both schools followed either zero or decreasing trends (i.e., "counter-therapeutic baseline"). Figures 1-4 present graphs of average on-task behavior across phases and conditions for each grade level at each school. As can be observed, the data paths for the no treatment condition during the alternating treatments phase are, for the most part, consistent with the data paths of the baseline phase. Also, there was an immediate change in on-task behavior with the introduction of the intervention. Additionally, there is a clear level difference between the two conditions as well as an absence of overlap between the data points of the two conditions, all of which indicate a condition/treatment effect. At the same time, however, the standard deviation bars of some of the data points in each condition overlap with the standard deviation bars as well as some data points of the other condition, which indicates relatively large between-person variability and which should be taken into account when interpreting these graphs. Collectively, these graphs provide preliminary evidence that students' on-task behavior levels were higher on days they participated in the before-school program.

Statistical Analysis

All statistical analyses were conducted separately for the two schools and were conducted by individual grade level as well as for the two grade levels combined. When models were tested for both grade levels combined, grade level was included as a covariate. Mean on-task behavior values by phase and condition are presented in Table 1.

Preliminary analyses. Analyses started by examining for potential effects of the design-based confounding variables of phase and order (see *Equation 3* for an example). The results of these analyses indicated that the confounding variable of order did not significantly contribute to the prediction of on-task behavior when controlling for treatment. At the same time, phase was found to significantly contribute to the prediction of on-task behavior above and beyond treatment only for third grade students at School B. Consequently, order was not included as a covariate in subsequent models, whereas phase was included as a covariate only for the specific group. The intercepts and regression coefficients for these variables are presented in Table 3 in Appendix C.

Primary analyses. Following the preliminary analyses, the random intercept model (see *Equation 2*) was tested to determine the (uniform) effect of the treatment across participants (first research question). The results for this model indicated a significant positive effect of the before-school program on students' on-task behavior**.** As can be observed in Table 2, for school A, on-task behavior levels significantly increased as a result of participation in the before-school program as follows: (a) B_1=17.80% for third grade, *pseudo*-R^2=.37 (strong effect), (b) B_1=14.10% for fourth grade, *pseudo*-R^2=.32 (strong effect), and (c) B_1=15.78% for both grade levels combined (controlling for grade level), *pseudo*-R^2=.34 (strong effect). For school B, the effects of the program were: (a) B_1=13.22% increase for third grade (controlling for phase), *pseudo*-R^2=.32 (for both treatment and phase) (strong effect), (b) B_1=13.15% increase for fourth grade, *pseudo*-R^2=.17 (moderate effect), and (c) B_1=14.26% increase for both grade levels combined (controlling for grade level), *pseudo*-R^2=.22 (moderate effect). *Pseudo*-R^2 values in this paragraph reflect proportion reduction in residual or level-1 (day-to-day) variance.

Next, a model was tested that included a random slope for treatment (see *Equation 4*). This model did not converge, even when the number of iterations was increased. This was the same when the model was tested with individual grade and school data, possibly indicating "…insufficient information to warrant allowing level-2 residuals for both initial status and rates of change" (Singer & Willett, 2003,

p. 156). In other words, the impact of the treatment was uniform across participants.

Subsequently, two separate models were examined (see *Equation 5* for an example) to test for the contribution of the person-level variables of sex and BMI status (normal weight vs. overweight/obese) in predicting average on-task behavior following the treatment (second research question). The results of these analyses indicated that all interactions except one were insignificant. The only significant interaction was the one for treatment and sex for third grade students in school B (B_4=-6.79, SE=3.32, p=.042; *pseudo*-R^2=.02). This interaction indicated that boys had lower on-task behavior and were impacted more by the treatment (B_0=57.11 + B_1=15.15), whereas girls had higher on-task behavior and were impacted less by the treatment (B_0=67.37 + B_1=8.36).

Discussion

The primary purpose of this study was to examine the impact of a before-school running/walking club on students' on-task behavior during the first 45-minute period of the day. For the purposes of this study, a two-phase experimental design was employed, with an initial baseline phase and an alternating treatments phase (no treatment vs. treatment). Analysis of the data included both a visual and a statistical analysis. Data analysis was conducted separately for each school since the purpose of the study was not to compare the two schools but rather to examine the effectiveness of the program in two different settings.

Visual analysis of data is commonly used in applied behavioral analysis studies. In this study, graphs of on-task behavior by grade level and school indicated that students' on-task behavior was consistently higher on days they participated in the before-school physical activity program than on days they did not. Additionally, statistical analysis results showed significant improvements for individual grade levels that ranged between 13% and almost 18%. School level analyses also indicated statistically significant improvements in on-task behavior on treatment days (School A=15.78%; School B=14.26%). Further, *pseudo-R^2* effect sizes indicated moderate to strong effects (range: .17 - .37).

The results of this study are in line with the results of previous studies that examined the impact of different types of physical activity on students' classroom on-task behavior. Mahar et al. (2011), in the only other study that examined the impact of a before-school physical activity program on third grade students' on-task behavior, found a significant increase of 18% from baseline to intervention (Cohen's d = 1.17), as well as a significant decrease of 15% from intervention to baseline (Cohen's d = 0.95).

Improvements in classroom on-task behavior were also found by studies that focused on classroom physical activity. Specifically, Mahar et al. (2006) found that third and fourth grade students' on-task behaviors significantly improved by over 8% from pre-Energizers to post-Energizers (Cohen's d = 0.60). Similarly, Goh et al. (2012) found that third to fifth grade students' on-task behavior significantly improved by 5% between pre-active and post-active lessons. On the contrary, Grieco et al. (2009), who also examined the impact of active classroom lessons on third grade students' time on-task via direct observation, did not find significant improvements in time-on-task following the active lesson. However, the authors did find significant decreases in time-on-task following the inactive control lesson.

Further, the results of studies that focused on recess also indicated significant improvements in classroom behavior. For instance, Jarrett et al. (1998) found a significant increase of 5% (Cohen's d = 0.51) in fourth grade students' on-task behavior as well as a significant decrease of 9% (Cohen's d = 0.94) in fidgety behavior on days with recess compared to days with no recess. Likewise, Ridgway et al. (2003) found that inappropriate behavior levels (including off-task behavior) significantly decreased for second grade boys with and without ADHD on days with recess (range of improvement: 15-41%). The results reported by Pellegrini et al. (1995) were mixed, indicating significantly lower inattention-to-task rates after recess than before recess, but only for some of the kindergarten, second, and fourth grade groups participating in the study. The study by Pellegrini and Davis (1993) was the only study showing that children who were more active during recess were more restless in the classroom, but the correlations in this study were very weak (< .20).

The present study's results did not show a differential effect of the treatment across individual students; however, this may be a function of the relatively small sample size and should be explored further in future studies. Other studies that grouped children based on their on-task behavior and/or attention levels found differential effects of physical activity on on-task behavior. For example, Ridgway et al. (2003) found greater effects of recess for most of the participants with ADHD (35%, 41%, and 15% improvement) than for the groups of participants without ADHD (16%, 22%, and 16% improvement). Similarly, Mahar et al. (2006) found a stronger effect (20% increase, Cohen's d = 2.20) for the least on-task students from pre-Energizers to post-Energizers.

Collectively, these findings provide evidence that physical activity programs before school and during the school day may help to increase classroom on-task behavior for all students and may have a greater effect for the students least on-task.

Although the mechanism underlying the relationship between acute physical activity and on-task behavior is unclear, potential mechanisms may relate to exercise-induced physiological changes that have been proposed as possible explanations for improvements in cognitive performance following exercise. These include increases in cerebral blood flow (Querido & Sheel, 2007), the release of several biochemical substances (e.g., neurotransmitters and growth factors) (Chaouloff, 1997; Diamond et al., 2004; Russo-Neustadt et al., 2001; Vaynman & Gomez-Pinilla, 2005), and a more general arousal mechanism (Kamijo et al., 2004; Polich & Kok, 1995). Several studies have found that acute bouts of physical activity positively influence students' executive functioning (e.g., Hillman et al., 2009; Kubesch et al., 2009), which involves several processes that also make it possible to stay focused (Diamond, 2013). It is likely, therefore, that improvements in executive functioning processes mediate the effects of physical activity on on-task behavior.

A secondary purpose of this study was to examine potential sex and BMI status differences (i.e., normal weight vs. overweight/obese) in on-task behavior levels following the treatment. Results indicated no BMI status differences in on-task behavior following participation in the before-school program. This finding is consistent with the results of the only other study identified that examined differences based on BMI category (Grieco et al., 2009), where no BMI differences were found in time-on-task prior to and following a physically active classroom lesson.

At the same time, results showed a significant interaction between treatment and sex for third grade students in school B, indicating that boys had lower on-task behavior levels on days without the treatment and were impacted more by the treatment. However, the effect size for this interaction was small (*pseudo*-R^2=.02). This, combined with the fact that the same interaction was insignificant for all other groups, suggests that the interaction results should be interpreted with caution. In the only other study indentified that examined sex differences, Jarrett et al. (1998) also indicated no sex differences in students' work and fidgety behavior following a recess physical activity break.

Strengths and Limitations

The strengths of the study include its design, which combined a baseline phase with an alternating treatments phase, thus controlling against several threats to internal validity. Another strength of the study is the replication of the project in a second setting, which provides support for both internal and external validity. Additionally, inter-observer reliability during the study exceeded 90% at both settings.

A limitation of the study was that the observers were not blinded to the conditions during the alternating treatment phase since this was not practically feasible. However, none of the observers knew whether participants accumulated at least five minutes of MVPA during the before-school program, which was the criterion for being considered as having participated in the program. At the same time, the high agreement rates between observers provide support for the objectivity of the data.

Another limitation of the study is the fact that the length of the baseline phase was predetermined, thus preventing the collection of data until all participants reached stable or negative trends. However, this is a limitation of using this type of designs with groups and, additionally, the individual baseline graphs of the majority of participants indicated zero or negative trends. Finally, due to the fact that the before-school program at the two schools took place on specific days of the week, it was not possible to randomly assign the conditions during the alternating treatments phase. However, non-treatment days were manipulated so they occurred both before and after treatment days.

Conclusion and Recommendations for Future Research

The results of this study provide additional support for the positive effect of physical activity programs on students' on-task behavior. In the long-term, such an effect may make a substantial contribution to students' academic performance, thus supporting the academic mission of teachers and schools. Teachers and school administrators may be reluctant to make the policy changes required for the adoption and implementation of physical activity programs throughout the school day, but before-school programs take no time away from academics and can still have a positive impact on students' on-task behavior during the first part of the school day as well as on their health.

This study's findings, therefore, have implications related to the structure of children's day and the school schedule. Typically, schools start early in the morning and children have little to no opportunities to engage in physical activity before school. Additionally, most physical activity and sport-related programs are scheduled after school. School personnel may want to consider later start times and to provide various opportunities for physical activity participation in the morning (in order to obtain the health, cognitive, and behavior benefits of physical activity participation for their students). Scheduling changes need not be drastic; a 20-minute or 30-minute delay in the start of the school day may be enough to provide children with a satisfactory amount of physical activity that can improve their readiness to learn. At the same time, in addition to changes in the start time of the school day, schools should also consider making appropriate arrangements regarding school buses, breakfast offered at school, and other factors that may influence children's opportunities to engage in physical activity before school.

Additional research is needed to further explore the effects of various types of physical activity programs on on-task behavior as well as other cognitive and academic measures. Cognitive measures that can be directly linked to physical activity (e.g., aspects of executive functioning – working memory, attentional control, etc.) may be a more fruitful route than focusing on academic performance or other measures that can be influence by numerous other factors. Further, it is recommended that future studies attempt to examine the duration of the effects of a before-school physical activity program on on-task behavior. This, however, can prove a difficult task due to the various competing variables that need to be accounted for (e.g., different teachers and different management styles, other physical activity opportunities, etc.).

Future studies should also use participants in middle and high schools since the majority of studies in this area have been conducted with elementary aged children. Finally, in order to better understand the influence of physical activity on on-task behavior and other cognitive and academic outcomes, it is recommended that future studies further explore potential differential effects of physical activity across individual students as well as across groups of students (e.g., girls vs. boys, normal-weight vs. overweight, etc.).

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Table 1

Mean Values of On-task Behavior by Phase and Condition

	Baseline Phase			Alternating Treatments Phase					
				No Treatment			Treatment		
	Mean	Within-Person *SD*	Between-Person *SD*	Mean	Within-Person *SD*	Between-Person *SD*	Mean	Within-Person *SD*	Between-Person *SD*
School A									
3rd Grade	59.47	12.48	4.09	58.82	9.82	5.60	76.56	8.69	5.14
4th Grade	63.51	9.61	7.52	61.60	8.17	7.71	77.00	7.69	6.48
Both Grade Levels	61.82	10.92	6.56	60.43	8.91	6.90	76.77	8.21	5.83
School B									
3rd Grade	60.28	10.04	8.14	64.57	10.38	8.65	77.83	9.43	6.88
4th Grade	64.14	13.01	6.89	64.32	12.69	5.38	77.58	11.40	5.31
Both Grade Levels	62.34	11.62	7.65	64.37	11.82	6.79	77.68	10.25	5.94

Note. No Treatment includes days during the alternating treatments phase on which participants either did not attend the before-school program or did not accumulate at least five minutes of MVPA within the program. Treatment includes days on which participants attended the before-school program and accumulated at least five minutes of MVPA.

Table 2

Estimates for On-task Behavior Random Intercept Models

	3rd Grade					
	School A			School B		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	59.15	1.53	< .001	60.18	2.04	< .001
B_1 (Treatment)	17.80	1.55	< .001	13.22	1.69	< .001
B_2 (Phase)	-	-	-	4.33	1.47	< .010
	4th Grade					
	School A			School B		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	62.46	1.70	< .001	64.23	1.38	< .001
B_1 (Treatment)	14.10	1.18	< .001	13.15	1.73	< .001
	Both Grade Levels					
	School A			School B		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	59.63	1.82	< .001	62.59	1.68	< .001
B_1 (Treatment)	15.78	.95	< .001	14.26	1.16	< .001
B_2 (Grade Level)	2.46	2.35	.303	1.40	2.23	.535

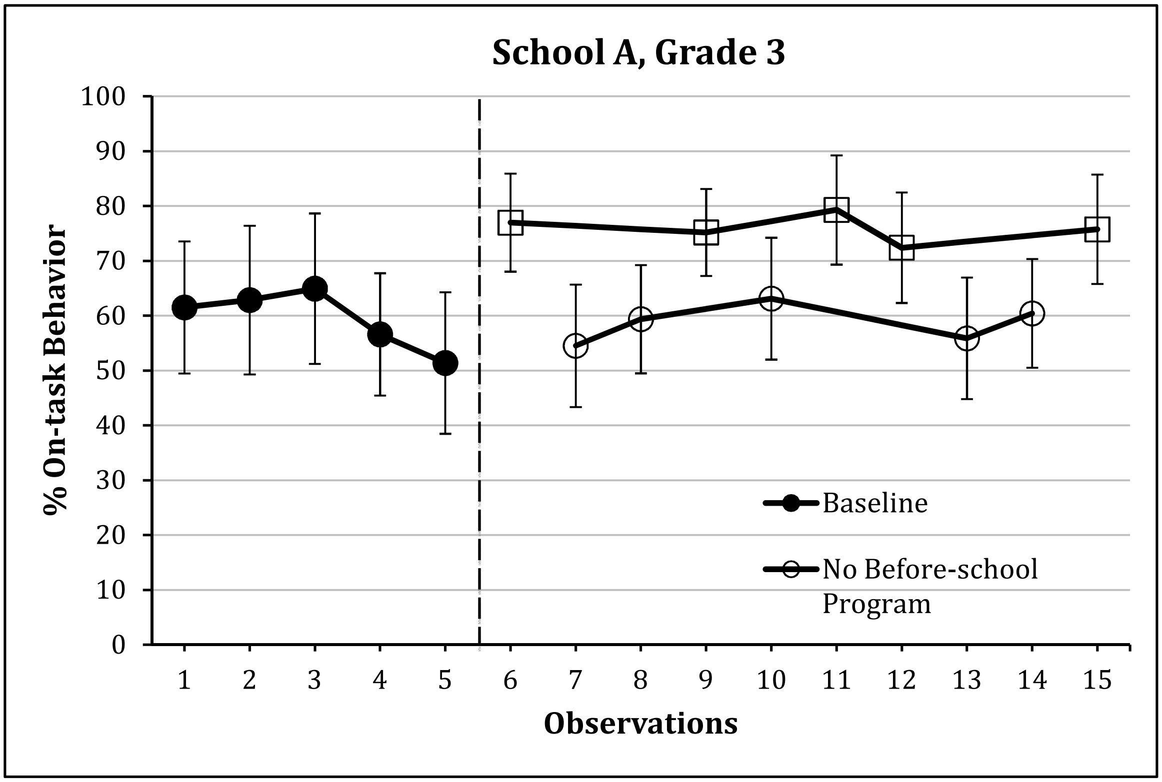

Figure 1. On-task Behavior Graph for School A, Grade 3.

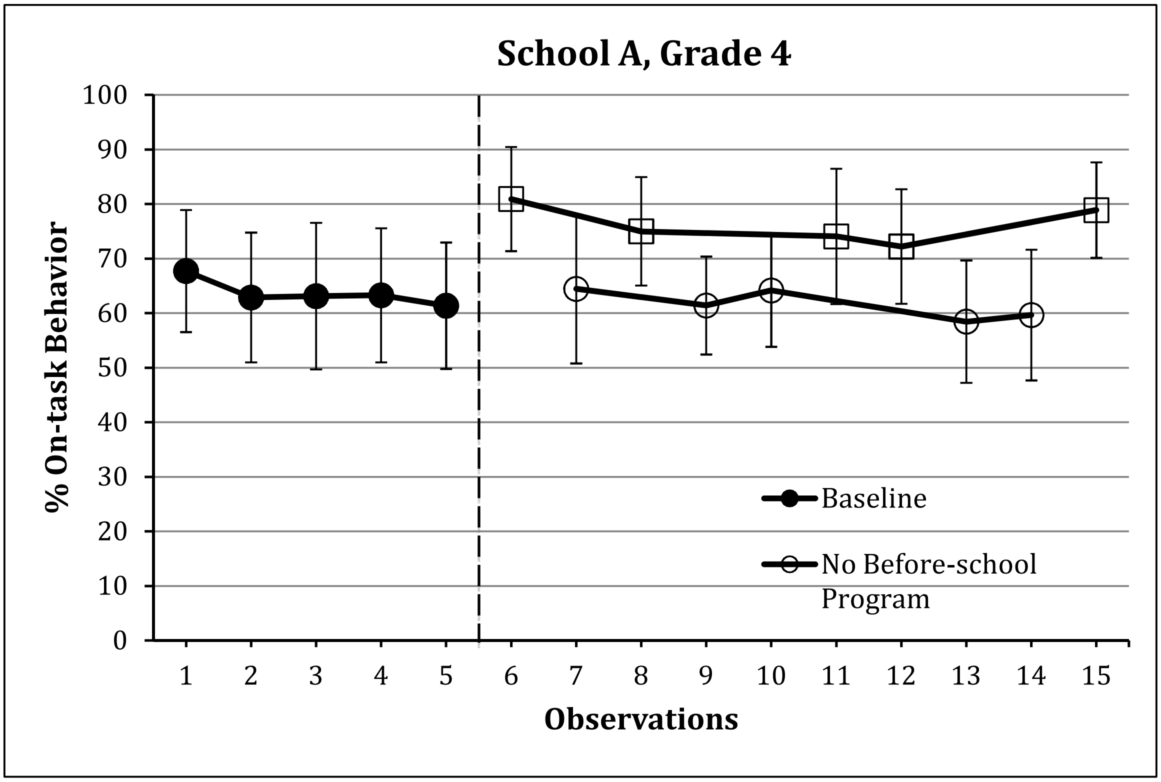

Figure 2. On-task Behavior Graph for School A, Grade 4.

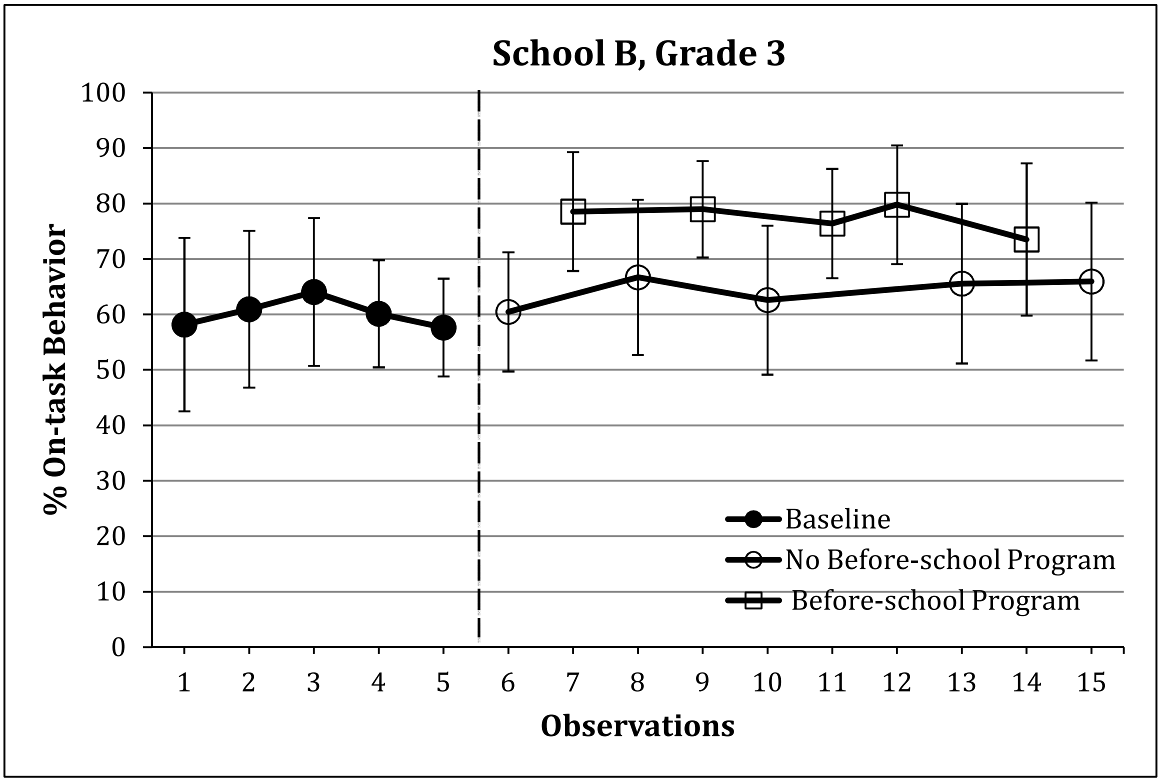

Figure 3. On-task Behavior Graph for School B, Grade 3.

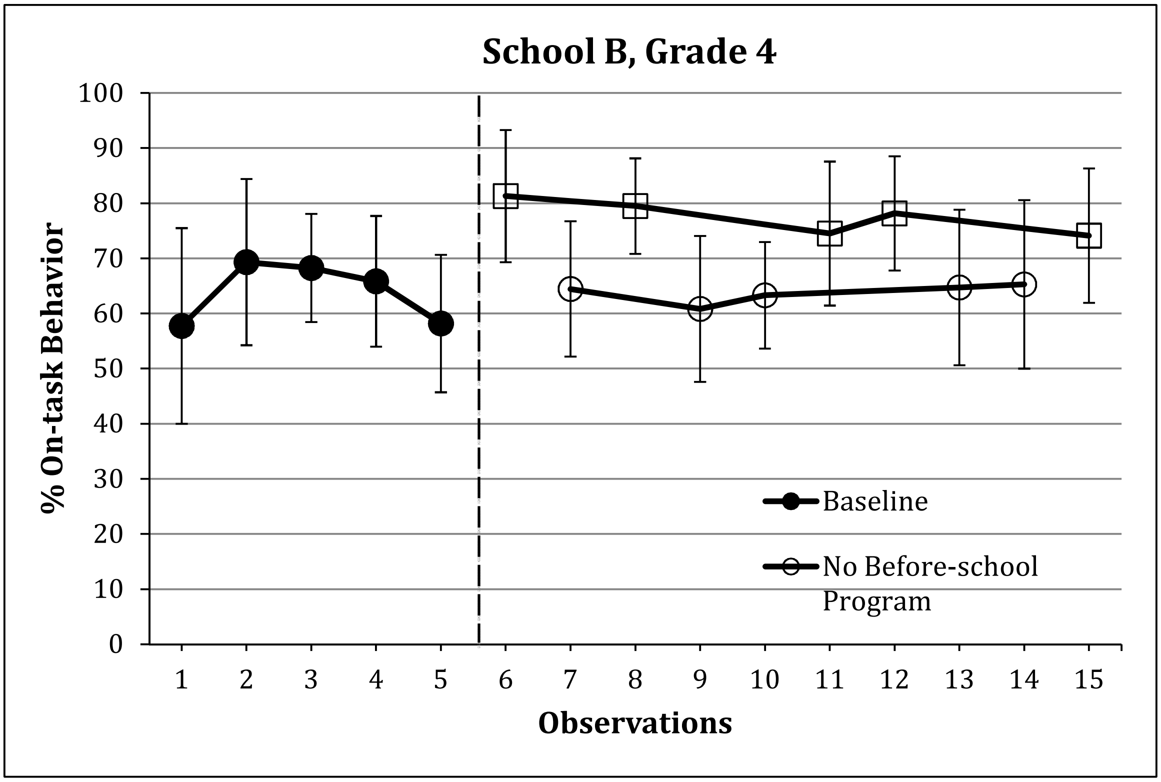

Figure 4. On-task Behavior Graph for School B, Grade 4.

Chapter 5: SUMMARY/CONCLUSION

Youth obesity is a major public health concern in the United States (e.g., Ogden & Carroll, 2010) and is associated with various adverse physical and psychological health outcomes (Daniels, 2006). Low levels of physical activity have been identified as a significant contributor to childhood and adolescent obesity (Brock et al., 2009; Jago, Baranowski, Thompson, Baranowski, & Greaves, 2005; Trost, Kerr, Ward, & Pate, 2001, Weinsier, Hunter, Heini, Goran, & Sells, 1998). At the same time, physical activity is associated with various health benefits as well as cognitive/academic benefits (e.g., CDC, 2010; Mahar, 2011; Sibley & Etnier, 2003). Schools have been indentified as ideal physical activity promotion sites (Institute of Medicine, 2013; Pate et al., 2006; World Health Organization, 2008) but, at the same time, school physical activity opportunities have decreased the last few years, mainly due the focus on improving academic performance (Center on Education Policy, 2007; Hardman, 2007).

Before-school physical activity programs provide a good opportunity for students to engage in physical activity without taking time away from academics. Such programs can help students increase their physical activity levels as well as improve their on-task behavior in the classroom. However, before-school physical activity programs constitute one of the least studied components of Comprehensive School Physical Activity Programs (CSPAP), a concept that was proposed in 2008 by the National Association for Sport and Physical Education in order to increase school-based physical activity engagement among children and adolescents.

Therefore, the purpose of this study was to examine the impact of a before-school running club on children’s physical activity and on-task behavior immediately following the program. Data for this study were collected from two different elementary schools in the Southwestern U.S. in order to examine the impact of such a program (i.e., replicate the study) in two different settings.

The results of this study indicated that children from both schools engaged in significant amounts of physical activity through the before-school program (School A: 1731.09 steps, 10:02 MVPA minutes; School B: 1502.27 steps, 8:30 MVPA minutes). The activity levels accumulated within both programs meet or exceed the standard of 50% of before-school program time spent in MVPA, as identified in the CSPAP Policy Continuum document (NASPE, 2012). Additionally, these amounts of physical activity represent substantial proportions of children's in-school physical activity and can help them meet or exceed daily physical activity recommendations. These results are consistent with the results of Mahar, Vuchenich, Golden, DuBose, and Raedeke (2011), the only other study identified that focused on a before-school program and used an objective measure of physical activity, who found that children spent an average of 46.4% (9.3 minutes) of their time present in the program in MVPA.

Although children in both schools engaged in substantial amounts of physical activity within the before-school program, they did not, overall, compensate by engaging in less physical activity throughout the rest of the school day (not including the before-school program activity). This finding is consistent with the results of previous studies that investigated compensatory effects relative to school-based physical activity opportunities. In the only other study that examined this question in reference to a before-school program, Mahar et al. (2011) did not find any significant differences in school-day physical activity on days children attended the before-school program. Likewise, the results of similar studies indicated that youth did not compensate for increased school-based physical activity opportunities by engaging in less physical activity after school or during the day (Alderman, Benham-Deal, Beighle, Erwin, & Olson, 2012; Dale, Corbin, & Dale, 2000; Morgan, Beighle, & Pangrazi, 2007). Further, some studies found that, overall, children engaged in more after-school and daily physical activity on days with increased school-based physical activity (Alderman et al., 2012; Dale et al., 2000; Long et al., 2013). On the other hand, only one study could be identified that found a compensation effect (Gidlow, Cochrane, Davey, & Smith, 2008). Collectively, these findings suggest that the physical activity accumulated within school-based programs, such as before-school programs, can substantially increase children's school-day and daily physical activity.

The results of this study revealed significant sex differences for physical activity levels both during the before-school program and the school day. Before-school program sex differences were only found for School B, with boys engaging in significantly more steps (438.97) and MVPA minutes (2:36) than girls. However, this finding should be interpreted with caution since these differences may be reflective of the fact that children arrived at the before-school program at different times. School-day sex differences in physical activity were found for both schools, again with boys engaging in significantly more steps (School A=1765.88; School B=583.27) and MVPA minutes (School A=09:13; School B=04:17) than girls. Such differences are often reported in the literature (e.g., Troiano et al., 2008; Trost et al., 2002) and highlight the need to pay particular attention to girls' physical activity patterns from a young age.

On-task behavior data were analyzed both visually and statistically. The visual analysis of graphs of on-task behavior by grade level and school indicated that students' on-task behavior was consistently higher on days they participated in the before-school physical activity program. Additionally, statistical analysis results showed significant improvements for individual grade levels that ranged between 13% and almost 18%. School level analyses also indicated statistically significant and meaningful improvement in on-task behavior on treatment days (School A=15.78%, *pseudo-*R^2=.34 [strong effect]; School B=14.26, *pseudo-*R^2=.22 [moderate effect]).

These results are in line with the results of previous studies that examined the impact of different types of physical activity on students' classroom on-task behavior. In the only other study that examined the impact of a before-school physical activity program on on-task behavior, Mahar et al. (2011) found a significant increase of 18% from baseline to intervention (Cohen's d = 1.17), as well as a significant decrease of 15% from intervention to back to baseline post-intervention (Cohen's d = 0.95). Significant improvements in classroom on-task behavior were also found by studies that focused on classroom physical activity (Goh, Hannon, Fu, & Prewitt, 2012; Mahar et al., 2006), as well as recess (Jarrett et al., 1998; Pellegrini, Huberty, & Jones, 1995; Ridgway, Northup, Pellegrin, LaRue, & Hightshoe, 2003).

Collectively, the results of these studies provide support for the positive effects of before-school physical activity programs on both students' physical activity and on-task behavior. Although there is evidence that additional time spent in physical activity during the school day does not hinder academic performance as well as that it can improve on-task behavior, cognition, and academic performance (e.g., CDC, 2010; Trost & van der Mars, 2010), school administrators and teachers may still be reluctant to make the policy changes required for the adoption and implementation of such programs. Before-school physical activity programs, however, provide a good opportunity for children to engage in physical activity without taking time away from academics and, at the same, improve children's readiness to learn. The findings of these studies can and should, therefore, be used to inform policy decisions related to the implementation of before-school physical activity programs. At the same, however, given the scarcity of research on before-school programs, it is recommended that future studies examine different types of before-school programs and related outcomes.

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APPENDIX A

University Human Subjects Institutional Review Board (IRB) Approval

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Pamela Kulinna ASU at the
From:	Carol Johnston, Chair Biosci IRB
Date:	10/04/2013
Committee Action:	**Expedited Approval**
Approval Date:	10/04/2013
Review Type:	Expedited F4 F7
IRB Protocol #:	1309009657
Study Title:	Effects of a before school physical activity program on physical activity levels and on-task behavior
Expiration Date:	10/03/2014

The above-referenced protocol was approved following expedited review by the Institutional Review Board.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date. You may not continue any research activity beyond the expiration date without approval by the Institutional Review Board.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Biosci IRB immediately. If necessary a member of the IRB will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Biosci IRB. The new procedure is not to be initiated until the IRB approval has been given.

Please retain a copy of this letter with your approved protocol.

APPENDIX B

Supportive Information for Chapter 3

Table 1

Participant Demographics

			3rd Grade		4th Grade		Total
			Male	Female	Male	Female	
School A	Ethnicity	White	5	10	8	12	35
		Other	-	1	1	2	4
	BMI Status*	Underweight	-	1	-	4	5
		Normal Weight	5	6	6	7	24
		Overweight	-	3	3	2	8
		Obese	-	1	-	1	2
	Total		5	11	9	14	39
School B	Ethnicity	White	10	4	7	9	30
		Hispanic	9	3	5	3	20
		Other	-	2	-	4	6
	BMI Status*	Underweight	1	-	-	-	1
		Normal Weight	9	8	5	13	35
		Overweight	4	1	3	1	9
		Obese	5	-	4	2	11
	Total		19	9	12	16	56

Note. *Based on CDC's BMI-for-age growth charts for boys and girls: <5th percentile = underweight; ≥5th percentile to <85th percentile = normal weight; ≥85th percentile to <95th percentile = overweight; ≥95th percentile = obese (http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html).

Table 2

Data Collection Schedule

SCHOOL A

Baseline Phase

Week 1					Week 2				
M	T	W	Th	F	M	T	W	Th	F
3rd	3rd	3rd	3rd	3rd	4th	4th	4th	4th	4th

Alternate Treatments Phase

Week 1				Week 2				Week 3		Week 4				Week 5				Week 6	
T	W	**Th**	F	M	**T**	**Th**	F	M	**T**	M	**T**	**Th**	F	M	**T**	**Th**	F	M	**T**
3rd	3rd	4th	4th	3rd	3rd	4th	4th	3rd	3rd	4th	4th	4th	4th	4th	4th	3rd	3rd	3rd	3rd

SCHOOL B

Baseline Phase

Week 1					Week 2				
M	T	W	Th	F	M	T	W	Th	F
3rd & 4th					3rd & 4th				

Alternate Treatments Phase

Week 1					Week 2					Week 3					Week 4					Week 5				
M	**T**	W	**Th**	F	M	**T**	W	**Th**	F	M	**T**	W	**Th**	F*	M*	**T**	W	**Th**	F	M	**T**	W	**Th**	F
3rd & 4th					3rd & 4th					3rd & 4th					3rd & 4th					3rd & 4th				

Note. The days in bold indicate treatment days (i.e., before-school physical activity program days). *Holiday or Field trip.

Table 3

Frequency of Participation at the Before-School Programs

School A			
Number of Times Attended (out of 5 times)	Total *n* (%)	Boys *n* (%)	Girls *n* (%)
5 times	12 (30.8)	5 (35.7)	7 (28.0)
4 times	7 (17.9)	1 (07.1)	6 (24.0)
3 times	4 (10.3)	4 (28.6)	0 (00.0)
2 times	10 (25.6)	1 (07.1)	9 (36.0)
1 time	6 (15.4)	3 (21.4)	3 (12.0)
	39 (100.0)	14 (100.0)	25 (100.0)

School B			
Number of Times Attended (out of 10 times)	Total *n* (%)	Boys *n* (%)	Girls *n* (%)
10 times	4 (07.1)	4 (12.9)	0 (00.0)
9 times	8 (14.3)	4 (12.9)	4 (16.0)
8 times	6 (10.7)	4 (12.9)	2 (08.0)
7 times	6 (10.7)	4 (12.9)	2 (08.0)
6 times	9 (16.1)	4 (12.9)	5 (20.0)
5 times	3 (05.4)	1 (03.2)	2 (08.0)
4 times	5 (08.9)	3 (09.7)	2 (08.0)
3 times	3 (05.4)	3 (09.7)	0 (00.0)
2 times	2 (03.6)	2 (06.5)	0 (00.0)
1 times	3 (05.4)	0 (00.0)	3 (12.0)
0 times	7 (12.5)	2 (06.5)	5 (20.0)
	56 (100.1)	31 (100.1)	25 (100.0)

Note. The study monitored participation in the before-school program five times for each grade level at School A and 10 times for each grade level at School B.

Table 4

Preliminary Analyses Estimates for PE and Extra Recess Models

	School A					
	Steps			MVPA (minutes)		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	5739	231	< .001	20:49	01:04	< .001
B_1 (PE)	1071	125	< .001	05:11	00:38	< .001
	School B					
	Steps			MVPA (minutes)		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	3876	120	< .001	15:23	00:41	< .001
B_1 (PE)	994	57	< .001	04:51	00:19	< .001
B_2 (Extra Recess)	1929	81	< .001	08:58	00:27	< .001

Table 5

Preliminary Analyses Estimates for Phase and Order

	Steps			MVPA (minutes)		
Phase						
School A						
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	6181	242	< .001	22:30	01:08	< .001
B_1 (Treatment)	-138	155	.375	-00:06	00:48	.901
B_2 (PE)	1008	123	< .001	04:58	00:38	< .001
B_3 (Phase)	-594	132	< .001	-02:28	00:41	< .001
School B						
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	3658	128	< .001	14:30	00:43	< .001
B_1 (Treatment)	328	72	< .001	01:25	00:24	< .001
B_2 (PE)	1009	56	< .001	04:55	00:19	< .001
B_3 (Extra Recess)	1958	80	< .001	09:05	00:27	< .001
B_4 (Phase)	209	63	< .010	00:48	00:21	.024
Order						
School A						
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	5235	277	< .001	19:33	01:26	< .001
B_1 (Treatment)	57	174	.744	00:50	00:54	.358
B_2 (PE)	1266	199	< .001	05:22	01:02	< .001
B_3 (Order)	53	190	.783	-01:10	01:00	.245
School B						
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	3757	171	< .001	15:00	00:57	< .001
B_1 (Treatment)	282	89	< .010	01:22	00:30	< .010
B_2 (PE)	1165	96	< .001	05:46	00:32	< .001
B_3 (Extra Recess)	1660	135	< .001	07:47	00:45	< .001
B_4 (Order)	88	126	.154	00:51	00:32	.113

School A	**School B**
Returned Consent & Assent Forms: 3rd Grade = 17 (Male=6; Female=11) 4th Grade = 23 (Male=9; Female=14) **Total** = 40 (Male=15; Female=25)	**Returned Consent & Assent Forms:** 3rd Grade = 28 (Male=19; Female=9) 4th Grade = 29 (Male=13; Female=16) **Total** = 57 (Male=32; Female=25)
Dropped Out: 3rd Grade = 1 (Male=1; Female=0) 4th Grade = 0 (Male=0; Female=0) **Total** = 1 (Male=1; Female=0)	**Dropped Out:** 3rd Grade = 0 (Male=0; Female=0) 4th Grade = 1 (Male=1; Female=0) **Total** = 1 (Male=1; Female=0)
Participated in Intervention (at least once) 3rd Grade = 16 (Male=5; Female=11) 4th Grade = 23 (Male=9; Female=14) **Total** = 39 (Male=14; Female=25)	**Participated in Intervention (at least once)** 3rd Grade = 25 (Male=17; Female=8) 4th Grade = 24 (Male=12; Female=12) **Total** = 49 (Male=29; Female=20)

Figure 1. Information related to the number of students who (a) volunteered to participate in the study, (b) dropped out, and (c) participated in the before-school program at least one time.

APPENDIX C

Supportive Information for Chapter 4

Table 1

Participant Demographics

			3rd Grade		4th Grade		Total
			Male	Female	Male	Female	
School A	Ethnicity	White	5	10	8	12	35
		Other	-	1	1	2	4
	BMI Status*	Underweight	-	1	-	4	5
		Normal Weight	5	6	6	7	24
		Overweight	-	3	3	2	8
		Obese	-	1	-	1	2
	Total		5	11	9	14	39
School B	Ethnicity	White	8	3	7	8	26
		Hispanic	5	2	4	3	14
		Other	-	2	-	4	6
	BMI Status*	Underweight	1	-	-	-	1
		Normal Weight	5	6	5	13	29
		Overweight	4	1	3	1	9
		Obese	3	-	3	1	7
	Total		13	7	11	15	46

Note. *Based on CDC's BMI-for-age growth charts for boys and girls: <5th percentile = underweight; ≥5th percentile to <85th percentile = normal weight; ≥85th percentile to <95th percentile = overweight; ≥95th percentile = obese (http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html).

Table 2

Data Collection Schedule

SCHOOL A

Baseline Phase

Week 1					Week 2				
M	T	W	Th	F	M	T	W	Th	F
3rd	3rd	3rd	3rd	3rd	4th	4th	4th	4th	4th

Alternate Treatments Phase

Week 1				Week 2				Week 3		Week 4				Week 5				Week 6	
T	W	**Th**	F	M	**T**	**Th**	F	M	**T**	M	**T**	**Th**	F	M	**T**	**Th**	F	M	**T**
3rd	3rd	4th	4th	3rd	3rd	4th	4th	3rd	3rd	4th	4th	4th	4th	4th	4th	3rd	3rd	3rd	3rd

SCHOOL B

Baseline Phase

Week 1					Week 2				
M	T	W	Th	F	M	T	W	Th	F
3rd	4th	3rd	3rd	4th	4th	3rd	3rd	4th	4th

Alternate Treatments Phase

Week 1				Week 2				Week 3				Week 4				Week 5			
M	**T**	**Th**	F	M	**T**	**Th**	F	M	**T**	W	**Th**	**T**	W	**Th**	F	M	**T**	**Th**	F
3rd	3rd	4th	4th	3rd	3rd	4th	4th	4th	4th	3rd	3rd	3rd	3rd	4th	4th	4th	4th	3rd	3rd

Note. The days in bold indicate treatment days (i.e., before-school physical activity program days).

Table 3

Estimates for Preliminary Analyses

School A						
3rd Grade						
	Phase			Order		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	59.49	1.73	< .001	58.73	1.69	< .001
B_0 (Coefficient)	-.63	1.51	.677	-3.05	1.67	.070
4th Grade						
	Phase			Order		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	63.55	1.79	< .001	61.24	2.10	< .001
B_0 (Coefficient)	-1.98	1.09	.071	-.33	1.39	.815
Both Grade Levels*						
	Phase			Order		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	60.40	1.88	< .001	58.87	1.96	< .001
B_0 (Coefficient)	-1.41	.90	.118	-1.60	1.08	.141

School B						
3rd Grade						
	Phase			Order		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	60.18	2.04	< .001	64.59	2.35	< .001
B_0 (Coefficient)	4.33	1.47	< .010	.17	1.93	.929
4th Grade						
	Phase			Order		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	64.07	1.66	< .001	62.66	2.09	< .001
B_0 (Coefficient)	.27	1.60	.868	1.08	2.00	.591
Both Grade Levels*						
	Phase			Order		
	Estimate	SE	*p*	Estimate	SE	*p*
B_0 (Intercept)	61.50	1.77	< .001	64.17	1.98	< .001
B_0 (Coefficient)	2.15	1.10	.051	.55	1.39	.690

Note. Controlling for treatment as well as grade level (for models with both grade levels combined).

School A

Returned Consent & Assent Forms:

3rd Grade = 17 (Male=6; Female=11)
4th Grade = 23 (Male=9; Female=14)

Total = 40 (Male=15; Female=25)

Dropped Out or Excluded:

3rd Grade = 1 (Male=1; Female=0)
4th Grade = 0 (Male=0; Female=0)

Total = 1 (Male=1; Female=0)

Observed

3rd Grade = 16 (Male=5; Female=11)
4th Grade = 23 (Male=9; Female=14)

Total = 39 (Male=14; Female=25)

Participated in Intervention (at least once)

3rd Grade = 16 (Male=5; Female=11)
4th Grade = 23 (Male=9; Female=14)

Total = 39 (Male=14; Female=25)

School B

Returned Consent & Assent Forms:

3rd Grade = 28 (Male=19; Female=9)
4th Grade = 29 (Male=13; Female=16)

Total = 57 (Male=32; Female=25)

Dropped Out or Excluded:

3rd Grade = 8 (Male=6; Female=2)
4th Grade = 3 (Male=2; Female=1)

Total = 11 (Male=8; Female=3)

Observed

3rd Grade = 20 (Male=13; Female=7)
4th Grade = 26 (Male=11; Female=15)

Total = 46 (Male=24; Female=22)

Participated in Intervention (at least once)

3rd Grade = 17 (Male=12; Female=5)
4th Grade = 21 (Male=10; Female=11)

Total = 38 (Male=22; Female=16)

Figure 1. Information related to the number of students who (a) volunteered to participate in the study, (b) dropped out or were excluded, and (c) participated in the before-school program at least one time.